

A
HISTORY OF HINDU CHEMISTRY
FROM

*THE EARLIEST TIMES TO THE MIDDLE OF THE
SIXTEENTH CENTURY A. D.*

WITH
**SANSKRIT TEXTS, VARIANTS, TRANSLATION
AND ILLUSTRATIONS**

BY
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VOL. I

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PREFACE TO THE FIRST EDITION.

Since the days of Sir W. Jones, Sanskrit literature, in almost every department, has been zealously ransacked by scholars, both European and Indian. As the results of their labours we are now in possession of ample facts and data, which enable us to form some idea of the knowledge of the Hindus of old in the fields of Philosophy and Mathematics including Astronomy, Arithmetic, Algebra, Trigonometry and Geometry. Even Medicine has received some share of attention. Wilson in a series of essays published in the *Oriental Magazine* (1823), Royle in his *Antiquity of Hindu Medicine* (1837), and Wise in his commentary on the *Hindu System of Medicine* (1845), were amongst the first to bring to the notice of the European world the contents of the ancient medical works of the Hindus, and recently the Thakur Sahib of Gondal has added his quota. These contributions are, however, of a fragmentary nature. A comprehensive history of Hindu medicine has yet to be written.

Materia Medica has also found, in Uday Chand Dutt, an able exponent. One branch has, however, up till this time, remained entirely neglected—namely, Chemistry. Indeed, it may be assumed that on account of its complex and technical nature it has hitherto repelled investigators.

The progress of chemical knowledge among the ancient nations has always had a fascination for me. The classical works of Thomson, Hoefer and Kopp have been my favourite companions for the last twelve years and more. In the course of my studies in this field I was naturally led to an inquiry into the exact position which India occupies therein, and with this view I undertook a systematic examination, from the chemical standpoint, of the Charaka, the Susruta and the various standard works of the Ayurvedic and Iatro-chemical Periods, which have escaped the ravages of time. It was at this stage that I was brought into communication with M. Berthelot some five years ago—a circumstance which has proved to be a turning-point, if I may so say, in my career as a student of the history of chemistry. The illustrious French savant, the *Doyen* of the chemical world, who has done more than any other person to clear up the sources and trace the progress of chemical science in the West, expressed a strong desire to know all

about the contributions of the Hindus,* and even went the length of making a personal appeal to me to help him with information on the subject. In response to his sacred call I submitted to him, in 1898, a short monograph on Indian alchemy; it was based chiefly on *Rasendrasara Samgraha*, a work which I have since then found to be of minor importance and not calculated to throw much light on the vexed question as to the origin of the Hindu Chemistry. M. Berthelot not only did me the honour of reviewing it at length but very kindly presented me with a complete set of his monumental work, in three volumes, on the chemistry of the

**Cependant il serait nécessaire d'examiner certains documents qui m'ont été récemment signalés par une lettre de RAY, professeur à Presidency College (Calcutta). D'après ce savant, il existe des traités d'alchimie, écrits en sanscrit, remontant au XII^e siècle, et qui renferment des préceptes pour préparer les sulfures de mercure noir et rouge et le calomel employés comme médicaments. Ces indications s'accordent avec celles des alchimistes arabes signalées plus haut. Il est à désirer que ces traités soient soumis à une étude approfondie, pour en déterminer l'origine, probablement attribuable à une tradition persane ou nestorienne."—JOURNAL DES SAVANTS, Oct., 1897.

+ "Matériaux pour un chapitre négligé de l'*histoire de la Chymie ou contributions à l'Alchimie indienne* (Mémoire manuscrit de 43 pages), par Prafulla Chandra RAY, professeur à Presidency College, Calcutta,"—Vide JOURNAL DES SAVANTS, April' 1898

Middle Ages, dealing chiefly with the Arabic and Syrian contributions on the subject, the very existence of which I was not till then aware of. On perusing the contents of these works I was filled with the ambition of supplementing them with one on Hindu Chemistry. Although I have written all along under the inspiration of a mastermind, it is not for a moment pretended that my humble production will at all make an approach to the exemplar set before my eyes.

When I first drew up the scheme of the present work, I had deluded myself with the hope of finishing the study of all the available literature on the subject before I took to writing. But I soon found that the task was one of vast magnitude. Some of my friends, whose judgment is entitled to weight, advised me under the circumstances, to curtail the scope of the work as originally planned out, and present a first instalment of it in its necessarily defective and imperfect shape (see Introduction, p. lxxxiv), reserving for a subsequent volume the working-up of the materials which are accumulating from time to time. In the present volume only one or two representative works of the Tanric and Iatro-chemical Periods have been noticed at length.

As regards the transliteration, I have not rigidly adhered to any particular system, but, in the

main, I have followed that of the *Sacred Books of the East*.

Before concluding, I must acknowledge the valuable assistance I have received from Pandit Navakānta Kavibhusana with whom I have toiled through many an obscure passage of the MSS. of the *Tantras*. His sound knowledge of the *Ayurvedas* has also been of much help to me.

* * * *

And now it only remains for me to discharge the grateful duty of expressing my thanks to the Government of Bengal, which at the instance of Mr. Alexander Pedler, F. R. S., Director of Public Instruction, placed a liberal grant at my disposal to enable me to meet various incidental expences, chiefly in the matter of collecting rare MSS.

PRESIDENCY COLLEGE.

Calcutta, May 1st, 1902.

}

P. C. RAY.

Word of Regards

Acharya Prafullachandra Ray (1861–1944) is regarded as a maker of modern science in India and also as a science-historian of international repute. Only at the age of twenty four, he introduced himself as one of the finest historian through his essay 'India before and after the mutiny'. Receiving his D.Sc. degree from Edinburgh University, he came back to India and joined Presidency College, Kolkata. In addition to his normal duties, he continued studies in the history of chemistry merely as 'hobby'. He completed the toughest book Kopp's '*Geschichte*' then Udooychand Dutt's '*Materia Medica of the Hindus*' and '*Alchimistes Grecs*' by M. Berthelot. Berthelot's book influenced Ray very much. We may quote few lines from his autobiography '*Life and Experiences of a Bengali Chemist*' which reads as follows :

'About this time I was brought into correspondence with the great French chemist himself. I had occasion to write to him to say that he was evidently not aware that in ancient India also alchemy was zealously pursued and that there are several treatises in Sanskrit on the subject. The reply which my letter elicited is characteristic of the man.....'

It was 1897. Prafullachandra was thirty-six years old. He received a long letter from seventy years old Marcellin Berthelot. A good portion of the letter will be of worth mentioning.

'I have received your chemical researches which are highly interesting and I have seen specially with pleasure how science with its universal and impersonal character is equally cultivated by all the civilised peoples of Asia as well as of Europe and America.

I ask your permission to invite your attention on certain information, you have given relative to the alchemy of India. Perhaps you are not aware of the works in 3 vols. that I have published on the History of Chemistry of the Middle Ages.

1. 1st vol. regarding the transmission of Asiatic Sciences. 2. 2nd vol. regarding Syrian Alchemy and 3. 3rd vol. regarding Arabian Alchemy.'

Berthelot wrote finally that it was Ray's letter which roused his curiosity.

Prafullachandra did not consider his 'hobby' as 'hobby' now. He became serious in his studies. He wrote a paper on the basis of first

few chapters of '*Rasendrasara Samgraha*' and forwarded it to Berthelot. The recipient of the paper elaborated the same in the form of an article and published in the '*Journal des Savants*'. Berthelot also sent all the 'three monumental volumes of his encyclopoedic work' on Syriac, Arabic and middle age alchemies to Ray. The episode reminds us the sending of a historical paper by Satyendranath Bose to Albert Einstein and its subsequent publication in the form of an article in an internationally reputed German Journal. After having all from Berthelot, what kind of reaction occurred in the mind of young P. C. Ray ?

'I greedily devoured the contents of these, and the idea now firmly took hold of me that I must write a history of Hindu Chemistry modelled upon the exemplars before me. I instituted a vigorous search for manuscripts bearing upon the subject and ransacked the pages of Aufrecht's *Catalogus Catalogorum*, Bhandarkar's, Rajendralal Mitra's, H. P. Sastri's and Burnell's Notices of Sanskrit MSS, and put myself in communication with the librarians in India and the India office, London, where some of the manuscripts have been preserved.'

Prafullachandra had a proficiency in Sanskrit but he rightly took the assistance of a Pandit named Navakanta Kavibhusan. Navakanta helped Ray for about five years till the manuscript of '*History of Hindu Chemistry*' (Volume-1) was over.

Prafullachandra wrote an excellent preface which speaks of itself. On the appearance of the book, there was immediate response from the institutions of intellect. The book was reviewed by a large number of journals from abroad and India. Some of them are '*Nature*', '*Journal of the American Chemical Society*', '*Knowledge*', '*The Times of India*', '*The Pioneer*' etc. Berthelot wrote a 15 pages review in the '*Journal des Savants*' (January 1903). '*Knowledge*' mentioned this book 'an instructive selection from the records of Hindu Chemistry (March, 1903)'. The volume was highly acclaimed by Dr. Mahendralal Sircar in his '*Calcutta Journal of Medicine*' (Vol-XXI, 10, October, 1902).

Svante Arrhenius (1859–1927), the Swedish physical chemist and the Nobel Prize recipient of 1903 wrote a book named '*Chemistry in Modern Life*'. Arrhenius quoted a large number of scientific informations from Ray's book.

Archives for the History of Science of Italy made a statement, '.....the capital work of Ray's that will cause his name to be remembered, is the magnificent history of Indian Chemistry from its origins to the middle of the sixteenth century'.

The first edition of the first volume of '*A History of Hindu Chemistry*' was published in the year 1902. The preface contained the date '1st May 1902, Presidency College'. Thus this outstanding work has completed its hundred years of publication. The second edition of the book was readily published after a two years interval in 1904. One can go through the preface of the second edition where Ray mentioned, 'A comparatively limited number of copies was printed in the first edition as it was feared that owing to its technical nature the work would appeal only to a select circle of readers. The exceedingly favourable reception accorded to it not only by the scientists and orientalists but also by the public in general both in Europe and in India has necessitated the bringing-out of a second edition.'

The second volume of '*A History of Hindu Chemistry*' was first published in 1909. The second edition of the same was found in 1925.

The unique excellency of the book is that it is not a mere description of science-history in different periods of India. For the first time, a working scientist made an attempt to understand the reason of decline of scientific spirit in our country. P. C. Ray introduced a separate chapter in its first volume naming 'Knowledge of Technical Arts and Decline of Scientific Spirit' where he clearly analysed 'the real cause of the decline of the scientific spirit in India not within the general framework of science itself but outside it i.e. mainly in the social conditions that developed in this country' (*History of Science and Technology in Ancient India, The Beginnings*, Debiprasad Chattopadhyaya, 1986).

Ray figured out two main factors for the decadance of science and technology in our country. First is the caste system and the second is the overemphasis on mental labour than the manual labour. As an Indian, it is a matter of great pride that this ideology has been later taken into consideration by B. Farrington in his two books '*Greek Science*' (1944) and '*Head and Hand in Ancient Greece*' (1947) and also by Joseph Needham in his multi-volume work '*Science & Civilization in China*'.

We also like to add few more words about this book. Indian Chemical Society, in 1948 resolved that a 'revised edition' of the said book will be published soon. 1954 is the year of publication of the landmark work by J. D. Bernal, '*Science in History*'. Two years later, P. C. Ray's book appeared in a new shape with a completely different name '*History of Chemistry in Ancient and Mediaval India*'. The book was edited by Priyadarjan Ray, a well-known chemist and a favourite student of Acharya P. C. Ray. The cover of the book contained the name Priyadarjan Ray and also the inner authorship owned by him. It is a fact that this new book has added a number of significant informations but it is also a matter of wonder that a good number of points raised by P. C. Ray have been omitted. This kind of revision always poses a question mark so far the ethical issues are concerned. P. C. Ray in Chemical Society's book is only living through 'incorporation'.

We had a dream to publish the original book after a long span of century. It became a reality because Dr. Rabin Bal, the back-bone of Shaibya Prakashan and his son Somnath were aggressive enough to be a part of this historical event. The equation of loss and profit is not always the sole word of a business-the venture is a propagation of this statement.

In fact, this centenary edition is a tribute to Acharya P. C. Ray, the illustrious son of India for his memorable contribution to science and society. This is a facsimile reprint of the two invaluable volumes of '*A History of Hindu Chemistry*'. The first volume is the facsimile of the second edition which was published in 1904. It is because 'some material additions have been made to the historical portion of the introduction, throwing further light on the independent origin of the Hindu system of medicine and its priority to that of the Greeks' (Preface by P. C. Ray, second edition, 1st January 1904).

We hope that this historical book will inspire us to develop a proper concept of science and technology-its prosperity and decadence with rational objectivity.

A HISTORY OF HINDU CHEMISTRY

Volume-I

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Erratum : Intro., p. civ, the 3 lines from the bottom upwards are to be deleted

Introduction

CHAPTER I

Alchemical Ideas In the Vedas

IN tracing the progress of chemical knowledge among the civilized nations of old, one always finds it intimately associated with medicinal preparations, metallurgical operations, the technical arts and the belief in the transmutation of metals. In India, more so than in Europe, chemistry has, however, been evolved chiefly as a handmaid of medicine ; and, somewhat later on, as an adjunct of the Tantric cult. The efficacy of the drug alone was by no means considered sufficient unless backed by the kindly interposition of the deities. Thus in the *Rigveda* we find the Asvins, the divine physicians, invoked, who give sight to the blind and make the lame walk. These twin gods have many points in common with the Dioskouroi of Greek mythology. One very Dawn of Hindu Alchemy.

curious myth is that of the maiden Vispalá who, having had her leg cut off in some conflict, was at once furnished by the Asvins with an iron limb.

The higher gods of the *Rigveda* are almost entirely personifications of the elements and the other natural phenomena, such as the fire and the wind, the sun and the dawn. But we often find also herbs and plants endowed with potent and active properties, raised to the dignities of the gods and addressed as such. The Soma plant is an object of particular adoration and the Vedic worshippers are in ecstasy over the exhilarating effects of the fermented juice expressed from it.¹⁾ The Soma rasa (juice) began even to be regarded as the amrita ; this immortal draught, allied to the Greek *ambrosia*, is "the stimulant which conferred immortality upon the gods . . . it is medicine for a sick man and the god Soma heals whatever is

1) See Eggeling's Intro. to "Satapatha Bráhmaṇa." Pt. 11, pp. 1, *et seq.* also Roth; Ueber den Soma; "Zeit. deut. morg. Ges." XXXV. pp. 680-692; also ibid, XXXVIII. 134-139: Wo wächst der Soma? And Windischmann: Ueber den Somacultus der

sick." It will be seen later on that in the Soma rasa and its attributes we have the dawn of Hindu Alchemy (*Vide p. 79*).

Other plants were likewise invoked as divinities. Thus one entire hymn is [devoted to the praise of plants (*oshadhi*) alone, mainly with regard to their healing powers.¹

Arier : Alhand. d. Münch. AK. d. Wiss. IV. B. Abh. 2.

(1) One or two typical hymns may be quoted here :—

या चोषधीः पूर्व्या जाता देवेभस्त्रिवुगं पुरा ।
मनौ तु वधुशास्त्रं शतं धामानि सप्त च
शतं वी अव्य धामानि सहस्रसुत वी रुहः । X.97.1.
अधा शतकल्तो यूद्यमितं मे अगदं कृत ॥ *ibid.*, 2

Sayana's commentary to the above is :—

या: चोषधयः पूर्व्याः पुरातन्यः जाताः उत्पद्धाः, केभ्यः सकाशात् ? देवेभ्यः ;
यहा देवाः द्योतमानाः शतवः, तेभ्यः । कस्मिन् काले ? चियुगं चिषु युगेषु
प्रादुर्भावपैषद्या छतादियुगमयसुक्तं, कल्पे तु अव्यक्तात्यत्वात् उपेचितम् ।
अथवा चिषु युगेषु वस्त्रे प्राह्णविश्वरदि चेत्यर्थः । अहं वधुशां वधुवर्णानां
सोमाद्योषधीनां शतं सप्त च धामानि अनुलेपमार्जनाभिविकादिहपेण
आशयभूतानि स्थानानि तु चिप्रं मनौ मन्त्रे संभावयासीत्यर्थः ।

हे अव्य मातरः चोषधयः वी युग्माकं धामानि स्थानानि जन्मानि वा
शतम् अपरिमितानि ; उत्तमिष च वी युग्माकं रुहः प्रसोहः प्रोदगमः
सहस्रपरिमितः । अधा अपि च हे शतकल्तः हे शतकर्णाचः यथमितं
नि मां नदीयं वा जन्मम् आमयस्तम् अगदं गदः रीगः तद्वर्हितं कृत कुरुत ।

plicity which is the characteristic beauty of the *Rigveda*, one *Rishi* says pathetically of himself :

“ Behold I am a composer of hymns, my father is a physician, my mother grinds corn on stone. We are all engaged in different occupations ” (IX. 112, 3),

“ Princes like Divodása, and bards and leaders of the tribe of the Angiras, administered medicines and gloried in effecting cures. A skilled physician is distinctly defined as one who lives in a place abounding with medicinal plants, and who assiduously devotes his time to the acquisition of knowledge ”.

The earliest literary record of Indian Medicine.

Thus not only in the Atharvan but even in the *Rik*, we can trace the earliest literary record of Indian Medicine.

The “Atharva-veda” deals chiefly with sorcery, witch-craft and demonology. There are deadly imprecations against evil-doers ;

(1) R. C. Dutt : “Civilisation in ancient India,” p. 65 (Calc. ed.)

(2) Introduction to “Astāñgahṛidaya” of Vagbhata, by Anna Morsvar Kunte, B. A., M. D., p. 2.

magical incantations for bringing about ruin, death, dementation and stupefaction of one's adversaries ; and charms intended to secure the love of women through the potency of various herbs. Some of them are of hostile character, being meant to injure rivals. The picture here presented has its counterpart in the ancient Egyptians, who were noted for their magical lore to which the Greeks were no less attached. There is a close resemblance between the contents of the A. V. and those of the Papyrus of Leyden in some essential features. In the latter also there is an intermixture of magic, astrology, alchemy as well as recipes for love philters.¹

The A. V., on account of its frequent calling-in-aid of super-natural agencies for selfish and malevolent purposes, has not generally been accorded the canonical sanctity of the Vedic Triad—The *Rik*, the *Yajus* and the *Sáman* ; the very authority of the fourth Veda as a

(1) The reader may compare this portion with Berthelot's "Les Origines de l' Alchimie," pp. 81-83.

scripture has been questioned in the several law-books of the Apastamba, the Vishnu, the Yájñavalkya and the Manu schools, and the practices it sanctions strongly condemned.

As Hindu medicine has seldom been able to shake itself completely free from the influence of magic and alchemy as auxiliaries, physicians; as practicers of the "black art," have been given an inferior position in the legal treatises. The Mahábhárata, reflecting the spirit of the above law-books, regards the physicians as impure. In spite of this "the Atharvan retains in a measure its place by virtue of its profound hold upon popular beliefs, because the Atharvan performs, especially for the king, inestimable services in the injury and overthrow of enemies."¹

In the A. V., the hymns for the cure of Rasáyana or Al. diseases and possession by chemy. demons of disease are known as "bhaishajyáni," while those which have for

(1) Bloomfield's "Hymns of the Atharva-veda":—Introduction, p. XLVI.

their object the securing of long life and health are known as “*áyushyáni*”—a term which later on gave place to *rasayana*, the Sanskrit equivalent of alchemy (see p. 80). We shall quote two under the latter heading as invocations to pearl and its shell and gold respectively. “Born in the heavens, born in the sea, brought on from the river (Sindhu), this shell, born of gold, is our life-prolonging amulet.”

“The bone of the gods turned into pearl; that, animated, dwells in waters. That do I fasten upon thee unto life, lustre, strength, longevity, unto a life lasting a hundred autumns. May the (amulet) of pearl protect thee !”

“The gold which is born from fire,⁽¹⁾ the immortal, they bestowed upon the mortals. He who knows this deserves it : of old age dies he who wears it.”

“The gold, (endowed by) the sun with beautiful colour, which the men of yore, rich in descendants, did desire, may it gleaming

(1) Among the five kinds of gold referred to in the “*Rasaratnamuchchaya*” (p. 105 रसरत्नमुच्चयः (born from fire) is one.

envelop thee in lustre ! Long-lived becomes
he who wears it ! ”

While gold is regarded as the elixir of life, lead is looked upon as the dispeller of sorcery: “ To the lead Varuna gives blessing, to the lead Agni gives help. Indra gave me the lead ; unfailingly it dispels sorcery.”¹

It is of interest to note the alchemical notions which had gathered round gold and lead² at the time of the A. V.

To the student of Hindu medicine and alchemy, the A. V. is thus of special interest as the earliest repository of information on the subject.

(1) The quotations are from Bloomfield’s A. V. pp. 62-65.

(2) In the alchemy of the West, lead, as is well known, is associated not with beneficent but “Saturnine” influence.

CHAPTER II

The Ayurvedic Period

We now alight upon a period when we find the Hindu system of medicine methodised and arranged on a rational basis.

The Hindu system of medicine methodised and arranged on a rational basis.

We now alight upon a period when we find the Hindu system of medicine methodised and arranged on a rational basis, with a scientific terminology.

The two great works of this period are the Charaka and the Susruta. In them we find the study of the subject to have made a distinct advance and to have been evolved out of the chaotic state it was in during the Vedic period. Of the two, the Charaka is by far the more ancient.¹

There must have been a wide gap between the age of the A. V. the Charaka and the Susruta, and that of the Charaka—an interval of probably a thousand years or more.

(1) Cf. "The theological doctrine of the nature of disease indicated its means of cure. For Hippocrates was reserved the great glory of destroying them both, replacing them by more practical and

In the latter the humoral pathology is fully developed, the diagnosis and prognosis of diseases described at length, and an elaborate mode of classification adopted. We have seen above that the physicians were assigned rather an inferior status in society; the healing art was, in fact, never recognised as a division of the Vedas.¹ Still the claims of the indispensable science of medicine, which can be distinctly traced to the A. V., could not altogether be ignored, and ultimately a compromise was arrived at. In the Charaka itself the Science of Life

material ideas, and, from the votive tablets, traditions, and other sources, together with his own admirable observations, compiling a body of medicine. The necessary consequence of his great success was the separation of the pursuits of the physician from those of the priest. Not that so great a revolution, implying the diversion of profitable gains from the ancient channel, could have been accomplished without a struggle. We should reverence the memory of Hippocrates for the complete manner in which he effected that object."—Draper's "Hist. of the Intellect. Dev. in Europe," I. p. 393 (ed. 1896). The services rendered by Charaka, Susruta and their predecessors were equally valuable.

(1) The six *limbs* or divisions of the Vedas are *sikshā* (phonetics), *kalpa* (ceremonial), *vyákarana* (grammar), *nirukta* (etymology), *chhandas* (metre) and *jyotisha* (astronomy).

(Ayurveda) is regarded as a secondary or subsidiary branch (*upāṅga*) of the Atharvan and as a direct revelation of the gods (Sútra : Ch. XXX. 8-9).

The Susruta even goes a step further and asserts that the self-existent (Brahmá) created Ayurveda, as an *upāṅga* of the Atharvan (sútra : 1. 3.)

We shall now concern ourselves with finding the time of Charaka within approximate limits. The task is not a light one, and it is one of the most abstruse questions of Indian chronology.

The age of Charaka.

M. Sylvain Lévi has recently unearthed from the Chinese Tripitaka the name of a physician named Charaka, who was attached as spiritual guide to the Indo-Scythian King Kanishka, who reigned in the second century A. D. The French Orientalist would have this Charaka as the author of the famous Hindu medical work, specially as it would offer an easy explanation of the supposed Greek influence discernible in it.

“Les éléments traditionnels mis en œuvre par les conteurs peuvent se résumer ainsi : le roi devaputra Kanishka, de la race des Kushanas, règne sur les Yuetchi, sept cents ans après le Nirvāna ; il est assisté de ministres éminents, nommés Devadharma et Māthara. Le bodhisattva Asvaghosha est son conseiller spirituel ; l'illustre médecin Charakā est attaché à sa personne.”

* * * *

“La mention de Charaka est la première indication positive obtenue sur la date du savant praticien qui dispute à Susruta la gloire d'avoir fondé la science médicale dans l'Inde. Les influences grecques qu'on avait cru reconnaître dans les doctrines de Charaka s'expliquent aisément, s'il est vrai que ce grand médecin vivait au temps et à la cour des Indo-Scythes, alors que l'hellénisme semblait pénétrer en vainqueur dans la vieille civilisation brahmanique.”

—“Journ. Asiatique” (1896), T. VIII. pp. 447-51

We confess we are by no means convinced of M. Lévi's theory. If we are to go by *name* alone, we can claim a still higher antiquity for our author. The appellation of Charaka occurs in Vedic literature as a patronymic ; in short, Pánini felt it necessary to

compose a special sútra for deriving the "Charakás" i.e. the followers of Charaka.¹ Then again, Patañjali, who is now generally admitted to have lived in the second century B. C., is known to have written a commentary on the medical work of Charaka, thus further proving the antiquity of our author;² and both Chakrapáni and Bhoja agree in alluding to him as the redactor of Charaka.³ Indeed, in such matters we would do well to set store by native traditions. It would be beside our purpose, however, to enter into any lengthy discussion on the grounds on which we are inclined to place Charaka in the pre-Buddhistic era, but we shall summarise below the salient points.

(1) कठचरकासुक् । 4. 3. 107.

(2) आसी नाम अनुभवेन वलुतस्त्वा काट्खेऽग्रम निश्चयान्,
रागादिवशादपि जायथावादी यः स इति चरके पतञ्जलिः । Quoted
in the "Laghu Mañjushá" of Nágesa Bhatta.

(3) पातञ्जल-महाभाष्य-चरकप्रतिसंख्यतैः ।

मनोवाक्-कायदीषाणां हत्येऽहिपतये नमः ॥

Vide salutation in the commentary named आयुर्वेददीपिका on the Charaka by Chakrapáni.

In the handling of the subject-matter the Evidence based Charaka is not so systematic upon the handling of the subject-matter, as the Susruta, but indulges in random, hap-hazard and irrelevant discourses, which make the reader often lose the thread of the main narrative. The author, whenever he has an opportunity, boldly and with evident relish, launches into metaphysical disquisitions, which, he believes, make up for lack of experiments and observations.¹ In this respect the Susruta is far more scientific than the Charaka. The Nyáya and the Vaisesika systems of philosophy, which have been interwoven into the body of the text, again remind us of a stage when they were more or less in a state of flux, but had not crystallised into the well-defined form and shape of the sútras in which they have come down to us—this also

(1) This has given ample scope to a recent commentator, the late Kavirāja Gangádhara Kaviratna, who in his अस्यकल्पतत्त्व, surpasses Charaka himself in philosophical dissertations.

goes towards proving the high antiquity of the Charaka.¹

Again, only Vedic gods and mantras figure in the Charaka, not a trace of Pauranic mythology being discernible in it.² Charaka follows closely the Vedic authority³ in counting the number of bones in the human body; the

(1) The Nyāya of Gotama enumerates 16 padárthas (categories), while Charaka under his (medical) disputation, वादमार्ग, mentions 44 categories (Vide Vimána. Ch. VIII. 22., also A. C. Kaviratna's Eng. trans. pp. 564-65). Bodas in his learned Introduction to the Tarkasamgraha of Annambhatta (pp. 12-14) places the aphorisms of Gotama and Kanada in the period between 400 B. C. to 500 A. D.

(2) The names of Krishna and Vásudeva occur in a salutation in the supplement added by Dridhavala. Chikitsita. Ch. 21. 92-93. ed. Gaṅgádhara). But Krisna-worship was in vogue at the time of Pánini ; 4. 3. 98. See also Lassen's Alterthumskunde 1. p. 648. Bühler also points out that "the earlier history of the puráṇas, which as yet is a mystery, will only be cleared up when a real history of the orthodox Hindu sects, especially of the Sivites and Vishnuites, has been written. It will, then, probably become apparent that the origin of these sects reaches back far beyond the rise of Buddhism and Jainism."—Intro. to "Apastamba," &c. p. XXIX..

(3) Namely 360; Sárára. Ch. VII, 5. According to the Institutes of Vishnu "it (the human frame) is kept together by three

limit of childhood he takes to be thirty years—quite in keeping with the conception of the heroic age.

It should, however, be borne in mind that the Charaka, as we now possess it, can by no means lay claim to be the first comprehensive and systematic treatise on Hindu medicine, it represents rather a more or less final development of the subject, just as the elaborate grammar of Pánini is based upon some twenty previous works of his predecessors, notably of Yáska, Sákalya, Sákatáyana, Gárgya and others.

The above has its parallel in the history of Greek medicine anterior to the time of Hippocrates. As Draper observes :

"Of the works attributed to Hippocrates, many writings of Hippocrates are doubtless the production of his family, his descendants, or his pupils. The inducements to literary forgery in the times of the Ptolemies, who paid very high prices

hundred and sixty bones" (XCVI. 55). This has been adduced by Jolly as a "reason in favour of the high antiquity of its laws." Vide Intro. to Vishnu, pp. XVIII-XX. See also Jolly's "Medicine" (Grundriss), p. 42.

for books of reputation, have been the cause of much difficulty among critics in determining such questions of authorship. The works indisputably written by Hippocrates display an extent of knowledge answering to the authority of his name ; his vivid descriptions have never been excelled, if indeed they have ever been equalled. The Hippocratic face of the dying is still retained in our medical treatises in the original terms, without any improvement."

Still more appropriate are the remarks of Littré on the works which now bear the name of "the father of medicine."

"Lorsqu'on recherche l'histoire de la médecine et les commencements de la science, le premier corps de doctrine que l'on rencontre, est la collection d'écrits connue sous le nom d'œuvres d'Hippocrate. La science remonte directement à cette origine et s'y arrête. Ce n'est pas qu'elle n'eût été cultivée antérieurement, et qu'elle n'eût donné lieu à des productions même nombreuses ; mais tout ce qui avait été fait avant le médecin de Cos a péri. Il ne nous en reste que des fragments épars et sans coordination ; seuls, les ouvrages hippocratiques ont échappé à la destruction ; et, par une circonstance assez singulière, il existe une grande lacune après eux, comme il en existait une avant eux : les

travaux des médecins, d'Hippocrate à l'établissement de l'école d'Alexandrie, ceux de cette école même ont péri complètement, à part des citations et des passages conservés dans des écrivains postérieurs ; de telle sorte que les écrits hippocratiques demeurent isolés au milieu des débris de l'antique littérature médicale.

Of internal evidence the first notable, and internal evidence, feature is the style.

The simple, unvarnished prose of the Charaka reminds one of the Bráhmaṇas of the Vedas. Thanks to the researches of Bühler and Fleet, we have now some idea of the prose Kábya style as it existed in the second century A. D. The literary prose inscriptions discovered at Girnár and Násik, although less ornate and artificial than the romances of Subandhu and Vána (seventh century A. D.), abound in long-winded metaphors and alliterations and thus stand in bold contrast with the simple prose of the Charaka.

Between the period of the A. V. and that of the Charaka there must have been com-

posed several medical treatises, each reflecting the spirit and progress of its age¹. At the time of the Charaka itself there existed at least six standard works by Agnivesa, Bhela, Játukarṇa, Parásara, Hárīta, and Kshárapáni, respectively. Charaka simply based his work on that of Agnivesa², which he completely recast and remodelled. Later on, Dridhavala added the last forty-one chapters³. The other five works seem to have perished⁴. Vágbhata,

(1) We are at present engaged in examining the Bráhmaṇas, the Upanishadas and Buddhistic literature with a view to glean information on these points and hope to announce the results in the second volume.

(2) Charaka himself naively assigns his reasons for giving preference to the treatise of Agnivesa in the words :—"of the six (authors) Agnivesa was the most "sharp of intellect" (sútra Ch. I 2.)

(3) विकारयति लेशीकं सञ्चिपत्यतिविकरम् ।

मस्तकं कुरुते तत्त्वं पुरावच्च पुनर्नवम् ॥ Siddhi. Ch. XII. 28.

Also Chikitsa, Ch. XXX. 112; ed. D. N. Sen and U. N. Sen.

(4) Cf. "We know how often in India the appearance of a convenient abstract has led to the neglect and subsequent loss of all earlier works on the subject."—Intro. to Stein's Rájatarñginí, p. 25. In Burnell's Tanjore catalogue Pt. I. pp. 63-65, a full analysis is given of Bhelasamhita, from which it would appear that this work is still extant, though in a mutilated form. Dr. Burnell

the epitomiser of the Charaka and the Susruta, mentions the works of Hárīta and Bhela, which were probably extant in his days.

On reading the Charaka, one often feels as if it embodies the deliberations of an international Congress of medical experts, held in the Himálayan regions to which even distant Balkh (Bactriana) sent a representative in the person of Kámkhayana (see p. 25). The work professes to be more or less of the nature of a record of the Proceedings of such a Congress.¹

Bodas in discussing the philosophical disquisitions of the Bráhmaṇas observes :

"It was a special function of the Brahmá priest to give decisions on any disputed points that may

remarks; "the most superficial comparison shows how much Vágbhata was indebted to this ancient work."

An "Hárīta Samhitá has recently been published; but its authenticity is questionable.

(1) Cf. 'La lecture de cet ouvrage nous initie aux comptes-rendus de véritables congrès philologiques et médicaux, dans lesquels des maîtres accourus des points les plus éloignés de l'Inde et même de l'étranger, prennent successivement la parole.'—Quelques Données Nouvelles à propos des TraitéS médicaux Sanscrits antérieurs au XIII^e siècle, par P. Cordier, p. 3.

arise in the course of a sacrifice, and this he could not have done unless he was a master of ratiocination. Such decisions, which may be likened to the chairman's rulings in a modern assembly, are scattered through the ancient Brāhmaṇas, and are collected together as so many Nyāyas in the Pūrva Mīmāṃsā aphorisms of Jaimini.”¹

We would invite the reader to go through the “Discourse on the Tastes” (pp. 25-28) and he will naturally agree that the above remarks apply with equal force to our author. In short, judging both from the manner and the matter of the work, we have little hesitation in placing it in the pre-Buddhistic era. We shall revert to the subject under Susruta.

As regards the Susruta we are on more solid grounds. Its terminology and *technique*, in general, do not differ much from those of the Charaka. In style the Susruta is rather dry, pithy, laconic, and matter-of-fact, as the Charaka is discursive and diffuse, and its composition altogether would point to a much later date.

(1) In. ro. to Annambhatta’s Tarkasamgraha, p. 28.

This is easily accounted for. The Susruta, such as has been preserved to us, is generally held to be a comparatively modern recension by the celebrated Buddhist Chemist, Nágárjuna,¹ who is said to have added the Uttaratantra or the Supplement.² Here for the first time in the history of Hindu Medicine and Chemistry, we come accross a personage who is historical rather than mythical (see below). That the redactor thoroughly recast and remodelled the Susruta is evident from the fact that there are numerous passages in it which agree almost *verbatim* with the Charaka, and which appears to have been amply laid under contribution.

(1) “यच यच पश्चिमे नियोगसाम तत्त्वैव प्रतिसंस्कारेऽसूत्रं ज्ञातव्यमिति
प्रतिसंस्कारात्पीड नावार्क्षुन् एव ”Vide Dalvana's commentary.

(2) Cf. “It is said by Dalvanáchárya, the commentator of Susruta, that at the time of war between the Buddhas and Hindus, the Susrutatantra was re-edited and rendered more comprehensive by the renowned chemist Siddhanágárjuna with a supplement called “uttaratantra.” Since that period it has been known by the name of Susruta Samhita.” Introduction to “Vaidyakasabda-sindhu” p. 6. by Kavirája Umesachandra Gupta Kaviratna.

The *Susruta* is *par excellence* a treatise on surgery¹ as the *Charaka* is on medicine proper. Ancient India must have acquired considerable skill in the handling of the lancet; for in the *Charaka* we find a distinction drawn between the “*Káyachikitsakas*,” *i. e.* the physicians properly so called, and the “*Dhanvantvarisampradáyas*” *i. e.* followers of *Dhanvantvari* or the Chirurgeons—a distinction which we have already noticed in the beginning of the Vedic Age.

The age of *Susruta* has been the subject of animated controversy for a long time past. The Hindus regard this branch of *Ayurveda* as a direct revelation from the Aswins or the Divine Surgeons (see p. i, Intro.). The origin of this myth can be traced to the *Rigveda* as already seen. In the *Mahábhárata*, *Susruta* is spoken of as the son of the sage *Visvámitra* and in the “*Vártikas*” of *Kátyáyana* (about 4th century B. C.) we

(1) For a description of the surgical instruments together with their drawings, see Wise: “Commentary on the Hindu System of Medicine, (1845) pp. 168-170.

also find mention of the same name. It is not, however, easy to establish any connection between these names and our present author. That there was a *Vriddha* (old) *Susruta*, existing as early as the fifth century A. D., has now been established almost beyond doubt. Dr. Hoernle, to whose profound scholarship and indefatigable labours the world is indebted for the excellent edition of the Bower Ms., has deduced from palæographic evidence that it must have been copied within the period from about 400 A. D. to 500 A. D.⁽¹⁾—a conclusion at which Prof. Bühler has independently arrived. The work professes to be by *Susruta*, to whom it was declared by the *Muni Kásirája*. The origin of the *Ayurveda* as given in the Bower Ms., is on much the same lines as in the *Charaka* and the mention in it, among others, of such names as *Hárita*, *Bhela*, *Parásara*, and the *Asvins* as founders of the science of medicine, would go to prove

(1) On the date of the Bower Ms., See "Journ. As. Soc."

LX. Pt. I. p. 79.

that even so early as the 5th century A. D., the old Susruta had come to be regarded as of mythical origin, and that therefore it must have been composed many centuries anterior to that time. Several important recipes as given in the Bower Ms., *e. g.* those of the "chyavānaprása," "silájatuprayoga" (the doctrine of bitumen p. 53) etc., occur in practically identical recensions in the Charaka. This is easily accounted for. The Charaka, the Susruta, and the Bower Ms., and even the *Ashtāṅgahṛidaya* of Vāgbhata have more or less a common basis or substratum. In order to understand this point more clearly it is only necessary to refer for a moment to the legal literature of the Hindus. The "Mānava Dharmasāstra" or the Institutes of Manu, which still exercises a potent influence in the regulation of the social life of the Hindus, is by no means the ancient work that it pretends to be. Modern research has shown that it is only a recension, or rather a recension of a recension, of "Dharmasūtras" connected with the Vedic Schools, incorpora-

ting at the same time the laws and usages of the age at which it was remodelled.¹

It would equally be a great mistake to suppose that the knowledge—chemical and therapeutical—which our Susruta embodies is only representative of the time of its final redaction. As a matter of fact it is a repository of the informations on the subject accumulated from the Vedic age to the date of its final recasting.

The remarks of M. Berthelot regarding a Greek technical treatise, which, from palæographic evidence, seems to have been written about the 11th century A. D., apply with still greater force to the Susruta.

“En effet la date de rédaction originelle n'est certainement pas le même pour les divers articles que le traité renferme : les uns étant plus anciens et remontant parfois jusqu'à l'antiquité gréco Egyptienne ; tandis que les autres reproduisent des recettes postérieures et des additions peut-être contemporaines du dernier copiste. En tous cas, ce traité continue la vieille tradition de l'orfèvrerie

(1) Vide Bühler's Introduction to “the Laws of Manu” : pp. XVIII et seq. “Sacred Books of the East,” Vol. XXV.

alchimique, qui remonte aux anciens Egyptiens."—
"Coll. des anciens alch. Grecs.," t. iii., trad. p. 307.

The period when the Susrura received its final cast must always remain an open question. Vágbhata in his Ashtáṅgahrídaya makes copious extracts both from the Charaka and the Susruta. The latter must therefore have existed in their present form prior to the 9th century A. D. Mádhavakara in his Nidána quotes bodily from the Uttaratantra, and as the Nidána was one of the medical works which were translated for the Caliphs of Bagdad (see below), it can safely be placed in the 8th century at the latest. It is thus evident that the present redaction of the Susruta must have existed anterior to that date, and that it had become at that age stereotyped as it were. The Vágbhata and the Nidána are simply summaries of the Charaka and Susruta,¹ and were written at a time when

(1) This statement we make in a qualified sense, and we fully agree with Roth when he observes "Udoy Chand Dutt in seiner Mat. Med. bezeichnet das Werk als eine methodische geordnete Compilation aus Charaka und Susruta. Ich glaube er thut ihm damit Unrecht: Vágbhata der sich übrigens mehr an

the latter had become very old, and were therefore studied by few experts, and their abstracts were likely to be prized by the general practitioners.

Vágbhata concludes his masterly treatise with the following observation, which is highly significant :—

" If a work is to pass current as authoritative simply because it is the production of a sage of old, why are the treatises of Charaka and Susruta alone studied and not those of Bhela and others ? It thus follows that whatever is reasonable [methodical and scientific] is to be preferred."²

Read between the lines the above is to be taken as an apology on the part of our author for appearing in the field ; it further establishes clearly that even during his life-

Susruta hält, ist nicht so unselbständige." " Zeit. deut. morg. Ges." 49. p. 184.

(1) e.g. Játukarna, Parásara, Kshárapáni, etc. see p. xxi.

(2) चृष्टिप्रचीते प्रीतिषेन्मुक्ता चरकसम्मुद्दो ।

मिकायाः किं न पक्ष्यन्ते तत्त्वादयाऽप्य सुभावितम् ।"

time the Charaka and the Susruta were regarded as *hoary with the prescription of age*, and their memories had passed into the region of tradition.¹

The earliest commentary of the Susruta
 The commentators of Susruta. that has been partially preserved to us is known as the Bhánumati by Chakrapáni Datta, the celebrated author of the medical work which goes by his name (about 1060 A. D.). The other well-known commentary, the Nibandha Samgraha, is by Dalvana, who lived in the reign of Sahanapála Deva whose kingdom was situated somewhere near Muttra. Dalvana acknowledges his obligations to the previous commentators, namely Jejjata, Gayadása, Bháskara, and Mádhava whose dates it is not easy to ascertain.

Since a remote period the text of the
 The purity of the text. Susruta has been jealously preserved and no tampering with it tolerated. Thus Dalvana refuses to

(1) On the age of Vágbhata see below under its proper heading.

recognise the authenticity of a passage, because an ancient commentator, Jejjata, has not noticed it.¹

We have been at some pains in arriving
 Haas on the age at an approximate age of the
 of Susruta composition of the Susruta,
 because attempts have been made now and then by a certain school of European scholars to prove that the medical works of the Hindus are of comparatively recent date. Haas has propounded the bold and astounding theory that the systematic development of Hindu medicine took place between the tenth and sixteenth centuries A. D.² We

(1) अनार्द्धं योगः जिज्ञासायेण नीकल्वात् । तत्प्राच पठनीयम् ।

Chikitsita. VII. 3.

Many such instances may be cited. For the purity of the text we are much indebted to these commentators.

(2) Kehren wir nunmehr wieder zur historischen Frage zurück, so können wir jetzt einen Anfangs—and einen Endpunkt aufstellen, zwischen welche wir mit einiger Sicherheit das Entstehen der systematischen Wissenschaft der Medizin bei den Indiern verlegen müssen, nämlich den Zeitraum von der Mitte des 10. bis Zur Mitte des 15. Jahrhunderts.—“Ueber die Ursprünge der Indischen Medizin, mit besonderem Bezug auf Susruta.” “Zeit. deut. morg. Ges.” XXX. p. 642.

shall see later on that this is precisely the period which marks the *decadence* of the Hindu intellect in the field of medicine and mathematics.¹ We should not have thought it necessary to discuss seriously the various arguments which Haas adduces in support of his views, some of which Dr. Hoernle curtly disposes of as "an elaborate joke," were it not for the fact that this German critic represents a school which cannot or will not see anything in India, which can claim originality or antiquity. In his blind zeal to support this theory, Haas has been led into the most egregious blunders. He comes to the strange conclusion that the works of Vágbhata, Mádhava and Sáriṅgadhara and others supply the germs, out of which the Charaka and Susruta have been elaborated, forgetting or ignoring that the former repeatedly and gratefully acknowledge their indebtedness to the latter.

(1) *Vide* "Decline of Scientific Spirit" pp. 190-198.

Haas is anxious to prove that the Hindus and the origin of Indian medicine borrowed their notions of humoral pathology from the Greeks, and that the *origines* of Indian Medicine are to be looked for in the writings of Galen and Hippocrates; indeed he goes so far as to suggest that the very name of Susruta is derived from the Arabic word Sukrat (=Sokrates), which is often confounded with Bukrat; the Arabic corruption of the Greek Hippocrates.¹ There is certainly a strange similarity between the chapter on "Initiation" in the Charaka and the "Eides" of Æsculapius as pointed out by Roth,² and there is also much in common between the doctrine of humoral pathology of

(1) No less preposterous is the etymology of Kásf (Benares), which Haas derives from Kos, the native place of Hippocrates.

(2) "Indische Medicin: Charaka," Z., D. M. G., Vol. 26. p. 441. Roth, whose knowledge of the Vedic and, to a certain extent, of the Ayurvedic, literature was encyclopedic, simply points out the analogy and stops short there. M. Liétard, who evidently borrows his information from Roth's article, jumps at once to the conclusion that the Hindus owe their inspiration to the Greeks!—Bull. de l'Acad. de Méd. Paris, May 5, 1896 and May 12, 1897.

the Greeks and the Hindus respectively—suggesting that borrowing may have taken place on one side or the other. But the Hindus would seem to have priority of time in their favour.

The doctrine of humoral pathology or at any rate the first beginnings of humoral pathology. of it can be traced so far back as the time of the *Rigveda*.¹

In the Atharva-veda, which may be looked upon as the parent of the Ayurveda, we naturally come across ample evidences of an ingrained belief in the causation of diseases by the disturbance of the humors. Thus we have such terms as “Vátíkrita,” i.e. a disease brought on by the derangement of the humor “Váta” (wind or air), “Vátagulmin,” &c.²

(1) * * * विधातु शर्म वहतं युभस्ती ॥ I. 34. 5.

Sáyana's commentary to the above:—

३६ युभस्ती श्राभनस्य चौवधजातस्य पालको युवा विधातु वात-पित्तस्तेष्वमनविद्यं शर्म सुखं वहतं प्रापयतम् ।

(2) This has been lately pointed out by Jolly (“Medicine” p. 41): The discussion on the term quoted above is so very important that we think it desirable to quote it at length:—

Early Buddhist literature also furnishes pre-Budhistic us with abundant proofs of in origin. this nature. On going through the chapter on " Medicaments " in the Mahávagga, we are often reminded of the contents of the Susruta.¹ From Pánini

"The history of the interpretation of this hymn is of uncommon interest, because it illustrates forcibly the particular closeness of relation between the hymns of the Atharvan and the practices reported in connection with them. Professor Weber, Indische Studien, IV, p. 405, translated the hymn under the caption 'Gegen hitziges fieber,' and guided especially by the more immediate meaning of *garāyugāh*, 'the product of the placenta, after-birth,' he thought that the hymn referred to puerperal fever, or the fever of a child. Ludwig, Der Rigveda, III, p. 343, surmised that the hymn was directed against inflammation, and Zimmer, Altindisches Leben, p. 390, refers to it in connection with the word *váta* in the first stanza, which he would translate by 'wound;' he also identifies *váta* with 'wound' etymologically. The compound *vátabhrágás* in the first stanza, as he understands, means 'suffering from wound-fever.' But Zimmer's theory that the word *váta* ever means 'wound' has not sustained itself: *váta* is 'wind in the body;' *vátkritanásanī* (VI,44,3²) is 'destroyer of the disease which comes from wind (of the body);' cf. *báta* *byádhī* (*vátavyádhī*), 'diseases produced by wind (in the body),' in Wise's Hindu System of Medicine, p. 250, and see Contributions, Fourth Series, Amer. Journ. Phil. XII, p. 427." Bloomfield's A. V. p. 246.

(1) One or two instances may be quoted here:—" Now at that time a certain Bhikkhu had a superfluity of humors in his body" —Vinaya Texts: pt. II. p. 60.

also we can glean technical terms as used in the Ayurveda, suggesting that a system of medicine existed in his life-time.'

We have thus what amounts to positive Positive historical historical evidence that during evidence. the life-time of Buddha and even much earlier the doctrine of humoral pathology and the Ayurvedic method of

"And the blessed one said to the venerable Ananda: 'A disturbance, Ananda, has befallen the humors of the Thathāgata's body"—*ibid.*, p. 191.

The various kinds of salts used in medicine as also the eye ointments, to wit, black collyrium [stibium], rasa ointment [rasāñjana], sota ointment [srotāñjana] &c. *ibid.* p. 90, are exactly the same as prescribed in the Susruta and other works on Hindu Medicine. (See also under *añjanas*, p. 93 of this book).

Note specially the reference to *vatthikarṇa* which is a Pāli corruption of the Sanskrit *vastikarma*:

"Now at that time the Chhabbaggiya Bhikkhus, since a surgical operation had been forbidden by the Blessed One, used a clyster."

No body has yet been bold enough to suggest that in the Mahāvagga Greek influence can be traced.

(1) The very terms Ayurveda and Ayurvedika i.e. expert in the Ayurveda occur in Pānini. We give below a list of some of the technical terms.

शिशुक्रन्दयसमसभहस्तेन्द्रजननादिभ्यश्चः ४।१.८८ ; परिवायवत्त्वासंज्ञा-
साक्षीः ३।१।१७ ; खार्योः प्राचाम् ५ ४ १०० ; खार्यो द्वैकम् ५ १।११ ;

treatment were in vogue.¹

In the Vártikas of Kátyáyana also (4th to 3rd century B. C.) the three humours of váta (air), pitta (bile) and sleshman (phlegm) are ranked together.

Regarding the age of the Vinaya Text, Rhys Davids and Oldenburg say :

"The Vibhanga and the Twenty Khandhakas were at that time (circa 350 B. C.) already held in such high repute that no one ventured to alter

आटकाचितपाचात् स्वाऽन्वतरस्याम् ५ १५१ ; लोमादिपामादिपच्छादिध्यः
श्वेलच्छः ५ २ १०० ; सिंचादिध्यष्ट ५ २४३ ; रीगाशापनयने ५ ४४२ ;
कालप्रयोजनादृग्गीरे ५ १२८१ ; अर्घं चादिध्योऽच् ५ १२१ १२७ ; रोमास्थायां
खुल् बहुकम् ५ १ १०८ ; कथादिध्यष्टज् ५ ४ १०६ ।

(1) The Jívaka Komúrabhachcha, who treats Buddha, derives his surname from "kaumárabhritya," a technical term for one of the eight divisions (astángas) of Ayurveda, meaning *treatment of infants*. *Vide* the Mahávagga, pt. II, p. 174.

In Asvaghosha's "Life of Buddha" we also read : "Atri, the Rishi, not understanding the sectional treatise on medicine, afterwards begat Atreya, who was able to control diseases."—Beal's trans. p. 11. This Atreya (Punarvasu) may have been the same sage who taught Agnivesa.

(2) Weber's "Hist. Sanks. Lit." p. 266, Eng. trans., ed. 1892.

them ; a sanctity of this kind is not acquired without the lapse of a considerable time : and we think it is not going too far to say, Firstly, that these books must have been in existence, as we now have them, within thirty years, earlier or later, of, at least, 360 or 370 B. C." (Intro. p. xxiii).

It is therefore evident that almost before
 The question of the birth of Hippocrates, the priority settled for Hindus had elaborated a good system of medicine based upon the humoral pathology. And yet Hass would have it that the Greeks, in the field of medicine as in several others, were the "pioneers and the first teachers of the world."¹¹

M Liétard very justly observes that if it could be proved that the doctrine of humoral

(1) "Wenn aber einmal der Boden von der Vorstellung geräumt ist, dass die Araber den Susruta und Charaka schon im 9. Jahrh. gekannt haben müssen, und wenn auf der andern Seite sich herausstellte, dass die Theorien der indischen Autoritäten in ihren Grundzügen mit denen des Galen übereinstimmten, so stünde nichts der Annahme im Wege, dass auch auf diesem Felde, wie auf so vielen andern die Griechen wieder das bahnbrechende Volk und die ersten Lehrmeister der Welt gewesen sind":—Z. D. M. G. Vol. 30. p. 670.

pathology was broached in India anterior to the time of Hippocrates, not only would the originality of the Hindus be established, but that of the Greeks would be compromised thereby.¹ The question may therefore be now taken as settled for good.

The capacity of a nation must be judged by what it has independently achieved in the several fields of knowledge and branches of literature—Mathematics, including Arithmetic and Algebra, Geometry, and Astronomy ; Phonetics, Philology, Grammar, Law, Philosophy, and Theology.

Cantor, the historian of mathematics, was so much struck with the resemblance between Greek geometry and the Sulva sútras that he, as is natural to the European, concluded that the latter were influenced by the Alex-

(1) "Il est évident que si l'on arrivait un jour à pouvoir reporter jusqu'au delà de l'époque d'Hippocrate, la formation de la doctrine médicale indienne, son originalité serait incontestable, mais, du même coup, celle de la médecine grecque serait fort compromise, puisque, comme je le rappellerai dans un instant, les theories sont à peu près identiques de part et d'autre."

andrian school of Hero (215 B. C.). The Sulva sútras, however, date from about the 8th century B. C., and Dr. Thibaut has shown that the geometrical theorem of the 47th proposition, Bk. I., which tradition ascribes to Pythagoras, was solved by the Hindus at least two centuries earlier,¹ thus confirming the conclusion of v. Schroeder that the Greek philosopher owed his inspiration to India.² Nor must we forget that the most scientific grammar that the world has ever produced, with its alphabet based on thoroughly phonetic principles, was composed in India about the 7th or 8th century B. C.³ As Professor Macdonell remarks : "we Europeans..... 2500 years later, and in a scientific age, still employ an alphabet which is not only inadequate to represent all the sounds of our

(1) Journ. As. Soc. Beng. 1875, p. 227.

(2) In his learned work: "Pythagoras und die Inder." pp. 44-59.

(3) See Goldstücker : "Pánini: his place in Sanskrit Literature"

tained notions similar to those of Haas, d'Alviella and others, but after his intimate acquaintance with the literature of the Hindus he had to change or modify his views. We

among scholarly circles, in the West. It would be perhaps too much to complain that classical scholars, for instance, should have a decided repugnance to admit any actual influence on Greek thought or institutions as having been exercised by the thinkers of the East, however ungrudgingly that privilege is conceded to Egypt. Personally I think that they are quite in the right in maintaining that such an influence is, except in a few instances, at present entirely unproven. But surely there are many points of analogy which are most instructive, and suggestive at least of more than an analogical connection; points that may throw light upon the natural course of the evolution of human conceptions and, in doing so, help to throw light on dark corners of the history of that culture out of which our own has arisen. It is a common saying that it is impossible to know any one language well without at the same time knowing another, and I venture to think that a similar remark holds good of the history of religion or of ethics, or of institutions, or of philosophy."

"I know of men who could not construe a line of Sanskrit, and who speak and write of your ancient literature, religion, and philosophy as if they knew a great deal more than any of your best Srotriyas. How often you must have smiled on reading such books! The idea that anything could come from the East equal to European thought, or even superior, never enters the mind of these writers, and hence their utter inability to understand and appreciate what is really valuable in Oriental literature. There is no problem of philosophy and religion that has not

are here reminded of the essay written by Dugald Stewart "in which he endeavoured to prove that not only Sanskrit literature but also Sanskrit language was a forgery made by the crafty Brahmins on the model of Greek after Alexander's conquest" (Macdonell).

been a subject of deep and anxious thought among your ancient and modern thinkers. We in the West have done some good work too, and I do not write to depreciate the achievements of the Hellenic and Teutonic mind. But I know that on some of the highest problems of human thought the East has shed more light than the West, and by and by, depend on it, the West will have to acknowledge it. There is a very able article in the last number of the *Edinburgh Review* (Jan. 1881), on Dr Caird's 'Philosophy of Religion.' Dr Caird is a representative man in England, and more familiar than most Englishmen with the solid work of modern German philosophers. And what is the last result at which Dr. Caird arrives and of which even the *Edinburgh Review* approves? Almost literally the same as the doctrine of the Upanishads! Dr. Caird writes: 'It is just in this renunciation of self that I truly gain myself; for whilst in one sense we give up self to live the universal and absolute life of reason, yet that to which we thus surrender ourselves is in reality our truer self.' And again: 'The knowledge and love of God is the giving up of all thoughts and feelings that belong to me as a mere individual self, and the identification of my thoughts and being with that which is above me, yet in me—the universal or absolute self, which is not mine or yours, but in which all intelligent beings

Those who attempt to prove that India owes her civilisation—or at any rate such advance and progress in the arts and sciences which make civilisation worth the name—to Hellenic influence seem to be only one degree removed from a Dugald Stewart.

After all, we are afraid, too much has been made of the resemblance between the Greek and the Hindu theory and practice of medicine. The analogy is more superficial than real.

alike find the realisation and perfection of their nature' (p. 257). I need not tell you or any one who knows the Upanishads how powerfully the same doctrine, the doctrine of the Atmā and Paramātmā, was put forth by your old Rishis.

"Many years ago I ventured to show that the five-membered syllogism of the Indian Nyāya philosophy is the best form that can be given to the syllogism of inductive logic. But European logicians cannot get over the idea that there is no logic like that of our school-men, and that every deviation from it is a mistake.

"The same conceit runs through almost all that is written on Indi. India may be patronised, some works of Indian poets and philosophers may be called clever and curious, but to recognise in anything the superiority of Indian thought, or the wisdom of Indian native opinion, that is out of the question.

"Bio. Essays :" Letter to K. C. Sen.

close examination. The Hindu system is based upon the three humors of the air, the bile and the phlegm, whilst that of the Greek is founded upon four humors, namely, the blood, the bile, the water and the phlegm—a cardinal point of difference.¹

Next to the Charaka and the Susruta, the Vágbhata, medical authority, who is held in the highest estimation throughout India, is Vágbhata, the author of *Asṭāṅgahṛidaya* (*lit.* heart or the kernel of the eight limbs or divisions of the Ayurveda). Indeed, in many parts of the Deccan the very names of Charaka and Susruta were forgotten, and Vágbhata is looked up to as a *revealed* author, and this is one of the reasons which led Haas to conclude that the former succeeded, and owed their inspiration to, the

(1) Cf. "I'ly a dans le corps quatre humeurs . le sang, la bile, l'eau et le phlegme."—Œuvres d'Hippocrate, T. vii. p. 475, ed. Littré, (1851). Again : "Les quatre humeurs, sang, bile, phlegme et eau, j'ai démontré comment et pourquoi toutes s'augmentent dans le corps par les aliments et les boissons."—*Ibid*, p. 557.

latter¹ (see *ante* p. xxxiii).

The treatise of Vágbhata may be regarded as an epitome of the Charaka and the Susruta with some gleanings from the works of Bhela and Hárīta, and contains little or nothing that is original.² In Surgery alone the author introduces certain modifications and additions. Mineral and natural salts chiefly figure in the prescriptions along with vegetable drugs; mercury is incidentally mentioned, but in such a perfunctory manner that it would not be safe to conclude that any compounds thereof are referred to. There are, however, a few metallic preparations recommended in it, which would presuppose an advanced knowledge of chemical processes.

The opening salutation of Ashtáṅga, which is addressed either to Buddha or some

(1) "An die Stelle des seines Vorrangs beraubten Susruta würde ich unbedenklich das Ashṭāṅgahrīdaya setzen"—Hippocrates und die indische Medizin des Mittelalters. Z D M.G., Vo 31, p. 649.

(2) See, however, *ante* p. xxix, foot note.

(3) Preface to Vaidyakasabdásindhu, p. 6.

Buddhistic emblem, clearly reveals the religious faith of 'its author, there is a tradition current among the learned Pundits of S. India, "that Vágbhata, formerly a Brahmin, was persuaded by a Bauddha priest to adopt his religion, which he embraced in the latter part of his life."¹ Internal evidence also fully supports our author's proclivities towards Buddhism,² and he seems to have flourished

(1) Preface to *Vaidyakasabdásindhu*. p. 6.

(2) See the numerous passages quoted by Dr. Kunte in his Introduction to *Vágbhata*, pp. 14-15.

The remarkable passage we have cited above, in which our author asserts the right every man to think for himself (p. xxix), is quite in keeping with the rationalistic age in which he lived, and he further observes in the same place that a medicine will have its efficacy all the same by whomsoever it is prescribed, be he Brahma himself or any body else. It should be commended to those who are lost in admiration over the "keen edged intellect" of *Samkara*, who does not find a better weapon to fight with his opponents than an appeal to the *Vedas* and other scriptures, see foot note to p. 195.

याते पित्ते श्वेषशांतौ च पर्यं
तैलं सर्वप्रसीकं च कमेच ।
एतद्व ब्रह्मा भाषते ब्रह्माणो वा
का निर्मेवे वक्तुभिदीक्षिकाः ॥
चमिधात्रवशात् किंवा द्रव्यशक्तिर्विशिष्यते ?

Uttara. XL. 85, 86.

at a time when the religion of Sákya Muni held its own in India. The Chinese pilgrim I'Tsing speaks of a compiler of the eight divisions of the Ayurveda—possibly this may refer to Vágbhata.¹

Cordier, following no doubt the authority of 'Vaidyakasabdásindhu,' states that, according to Rájataranaginí, Vágbhata lived at the time of King Jayasimha (1196-1218 A. D.) ; this view is quite untenable, and it is one of the many instances which would go to prove that Kalhana in writing his Chronicles had often to draw largely upon vague traditions, and hence his dates are to be accepted *cum grano salis*.²

(1) "These eight arts formerly existed in eight books, but lately a man epitomised them and made them into one bundle."—I'Tsing : "Records of the Buddhist Religion" by Takakusu, p. 128.

(2) The eminent Sanskrit scholar, the late A. M. Barua, in discussing the age of Kshirasvami discards the authority of Rájtaranaginí and observes:—"I do not see any valid reason for regarding it as a historical authority for all its statements and the more I learn the more my view is confirmed." The name of Vágbhata, however, does not occur in Stein's edition of *Ráj*, which may be pronounced as the most reliable that has yet appeared.

Csoma de Körös was the first to announce that the Thibetan Tanjur contains among others translations of the Charaka, the Susruta, and Vágbhata.¹ Georg Huth, who has recently critically examined the contents of the Tanjur, concludes that the most recent date at which it can be placed, is 8th century A. D.² This is in agreement with the fact that the Vágbhata was one of the medical works translated by order of the Caliphs. But no positive information as regards the most distant date is yet available;³ Kunte, from internal evidence, is inclined to place him "at least as early as the second century before Christ."

That Hindu Pharmacopœia in the 7th century ran on the lines of the Charaka and the Susruta, and did not include any ea-

Hindu Pharmacopœia in the 7th century.

(1) Journ. Asiatic Soc. xxxvii. (1835).

(2) Zeit. deut morg. Ges, T. lxix, pp. 279-284.

(3) Regarding the bibliography of Vágbhata, see two short monographs by Dr. Palmyr Cordier; also Julius Jolly : "Zur Quellenkunde der indischen Medizin," I. 'Vágbhata, Zeit. deut. Morg. Ges. LIV. pp. 260-74.

borate metallic preparations is evident from the testimonies of Vána and of the Chinese pilgrim, I-Tsing. Thus, we read in the Harsha-Charita : "among their number, however, was a young doctor of Punarvasu's race named Rasáyana, a youth of about eighteen years of age, holding an hereditary position in the royal household, in which he had been cherished like a son by the King. He had mastered Ayurveda in all its eight divisions, and, being naturally of an acute intellect, was perfectly familiar with the diagnosis of diseases :" I-Tsing also records : "I made a successful study in medical science, but as it is not my proper vocation, I have finally given it up."² In his rules on giving medicine he further lays stress on abstinence and fasting and recommends such drugs as the myrobalans, ginger, pepper, liquorice, etc.

(1) Cowell and Thomas' Trans. pp. 143-144.

(2) Takakusu : "Records of the Buddhist Religion," p. 128.

In both instances, in vain do we look for any metallic salts, which form the leading features of the later Tantric and Iatro-Chemical Schools.¹

(1) See, however, below under the marginal heading :
“The age of the Tantras dealing with mercury.”

CHAPTER III

The Transitional Period

Circa 800—1100 A. D.

VRINDA AND CHAKRAPANI

We now come upon a period which determines the parting of ways in the progress of Hindu medicine. Hitherto we have been chiefly concerned with herbs and simples and a few readily available products of the mineral kingdom. About the year 1050 A. D. Chakrapáni Datta, himself a learned commentator of both the Charaka and Susruta, wrote the celebrated medical treatise which bears his name. Since the days of Vagbhata, metallic preparations had begun slowly to creep into use, and at the time of Chakrapáni and his predecessor Vrinda, they had so fully established their claims that they could no longer be ignored. Thus we find from

the tenth century and downward every medical work more or less recommending compounds of metals which can only be synthetically prepared.

It should not, however, be forgotten that Susruta at times shows a knowledge of pharmacy, unsurpassed in the later Hindu medicine.

Although Chakrapáni belonged to the Brahmanical creed, his writings show a decided leaning towards Buddhism. Thus Maghadha itself is named महाबोधिनदेश or the country of the Mahábodhi ; we have also such expressions as बोधिसत्त्वेनभाषितं, सुखावतौ चर्ति, सौगतमञ्जनम् । This might well be expected, for Chakrapáni's father was physician to king Nayapála, the successor of Mahipála, who ascended the throne about 1040 A.D.¹

(1) The author, fortunately for future historians, has given an account of himself in a colophon :—

गीकाधिकावरसदव्याधिकारिपादः
नारायणस तनयः सुमघोइक्तरकात् ।

Both *Vrinda* and *Chakrapáni* mention Nágárjuna as an authority, and they follow closely in the footsteps of Charaka, Susruta and Vágbhata ; but at the same time they are amenable to the influences brought to bear upon medicine by the Tantras.

Indeed, they go so far as to recommend the uttering of the cabalistic interjections of the votaries of the Tantric cult with a view to increase the efficacy of some of their preparations.¹ (see *ante p. i.*)

Dr. Hoernle observes : "it would be satisfactory to be able to discover what

भग्नारण्यं प्रचित्तलोप्रवली कुलोनः
श्रीचकपाणिरह कर्मपदाधिकारी ॥

"The author of this work is Sri C. P., who belongs to the family of Lodhrávali and who is younger brother of Bhánu and the son of Náráyana, the superintendent of the kitchen of the King of Gour." Regarding the date of Nayapála, *vide* Cunningham's "Archaeological Survey of India," III. p. 119, also Journ. As. Soc. LX. Pt. I. p. 46, Life of Atisa by S. C. Dásá.

(1) अयं सत्त्वः प्रथोक्तव्यो भिषजा चाभिसत्त्वणे ॥

षां बमो विनायकाय अस्ति रक्ष रक्ष मम फलसिद्धिं
देहि देहि शद्रवचमेन स्थाहा । १० इन्द्रसायनाधिकारः ।

the sources were on which Chakrapáni drew for his compilation ; they are not specified anywhere, I believe, in his work." ¹ It is not easy to account for the above remarks, seeing that Chakrapáni distinctly mentions that he has modelled his work on the Siddha-yoga of Vrinda, ² and that he draws largely upon the Charaka, the Susruta and the Vágabhata, all of whom he quotes verbatim and at length.

The religion of Sákyamuni inculcates the alleviation of distress and suffering, both moral and physical, as one of the essential articles of faith, and hence we find throughout

“इहमिह हृषीपकारणमेतद्वर्णत भवेष ।

स्वाहानेन विमहों भवति फङ्गनेन स्वोहवक्तव्या ।

सुनमस्कारेण वस्तिर्भवयमयसो इमनेन ॥

“चों अमृतोहवाय स्वाहा ।” “चों अमृते हूं फट् ।”

“चों नमश्चवज्ञपादये महायच्छसेनाधिपतये सुरगुरुविद्या-

महावक्तव्य स्वाहा ।” “चों अमृते हूं । इति चक्रपादि-
रसायनाधिकारः ।

(1) Journ. As. Soc. Beng. LX. pt. 1. p. 150.

(2) यः सिद्धयोगसिद्धिताधिकसिद्धयोग-
नवैव निषिपति केवलसुहरेवा ।

Buddhistic India hospitals attached to the numerous monasteries for the treatment of man and beast alike.¹ It would also appear that inscriptions were engraved on rock pillars giving recipes for the treatment of diseases. Thus both Vrinda and Chakrapáni speak of a formula for a collyrium as inscribed on a stone pillar by Nágárjuna at Pátaliputra : नागार्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ।

Chakrapáni bases his work on that of Probable date of Vrinda, who again follows Vrinda. closely the order and the pathology of the Nidána of Mádhavkara.² It necessarily follows that Vrinda was a recognised authority at least one or two centuries before the time of Chakrapáni and that the former was preceded by the Nidána by at least as many centuries and thus we have internal evidence of the exis-

(1) "Everywhere the King Piyadasi, beloved of the Gods, has provided medicines of two sorts, medicines for men and medicines for animals." Edict II. of Asoka.

(2) Vrinda himself admits this :

ठन्डन * * * संस्कृते गदविनिषयक्रमेण ॥

tence of the Nidána in the eighth century as the lowermost limit—a date which is further corroborated by the fact that the Nidána was one of the medical treatises translated by order of the Caliphs.

As regards alchemy in India in the XIth century, we cannot do better than quote *in extenso* Albérúní, who was well versed in Arabic and Greek astronomy, chemistry etc.

Alchemy in the eleventh century.

“ The Hindus do not pay particular attention to alchemy, but no nation is entirely free from it, and one nation has more bias for it than another, which must not be construed as proving intelligence or ignorance ; for we find that many intelligent people are entirely given to alchemy, whilst ignorant people ridicule the art and its adepts. Those intelligent people, though exulting boisterously over their make-believe science, are not to be blamed for occupying themselves with alchemy, for their motive is simply excessive eagerness for acquiring fortune and for avoiding misfortune. Once a sage was asked why scholars always flock to the doors of the rich, whilst the rich are not inclined to call at the doors of scholars. ‘ The scholars,’ he

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answered, 'are well aware of the use of money, but the rich are ignorant of the nobility of science.' On the other hand, ignorant people are not to be praised, although they behave quite quietly, simply because they abstain from alchemy, for their motives are objectionable ones, rather practical result of innate ignorance and stupidity than anything else.

"The adepts in this art try to keep it concealed, and shrink back from intercourse with those who do not belong to them. Therefore, I have not been able to learn from the Hindus which methods they follow in this science and what element they principally use, whether a mineral or an animal or a vegetable one. I only heard them speaking of the process of *sublimation*, of *calcination*, of *analysis*, and of the *waxing of talc*, which they call in their language "tālaka," and so I guess that they incline towards the mineralogical method of alchemy.

"They have a science similar to alchemy which is quite peculiar to them. They call it *Rasdyana*, a word composed with *rasa* i.e. gold.¹ It means an art which is restricted to certain operations, drugs, and compound medicines, most of which

(1) See, however, p. 79, for the meaning of the term 'rasa'

are taken from plants. Its principles restore the health of those who were ill beyond hope, and give back youth to fading old age, so that people become again what they were in the age near puberty; white hair becomes black again, the keenness of the senses is restored as well as the capacity for juvenile agility, and even for cohabitation, and the life of the people in this world is even extended to a long period. And why not? Have we not already mentioned on the authority of Patañjali that one of the methods leading to liberation is Rasāyana? What man would hear this, being inclined to take it for truth, and not dart off into foolish joy and not honour the master of such a wonderful art by popping the choicest bit of this meal into his mouth?" Sachau's Trans. Vol. I. pp. 187-88.

CHAPTER IV

The Tantric Period

Circa 1100 A.D.—1300 A.D.

Before we proceed further it would be advisable to take a hasty Origin of the Tantric Cult glance at the origin of the Tantric Cult, as Indian Alchemy very largely derives its colour and flavour from it. In almost every country the progress of chemistry can be traced to medicine and the belief in the artificial gold-making,—the search after *elixir vitæ* and the philosopher's stone. In India, however, these ends have played a secondary part in promoting a knowledge of the chemical processes. Here the origin of astronomy, geometry and anatomy is to be sought in the exigencies of religious rites.¹ No less

(1) Cf. the opening remarks by Dr. Thibaut on the "Sulva-sútras":—

is the case with alchemy. We have already seen how the Atharva-veda deals almost exclusively in charms, sorcery, exorcism of diseases by means of amulets and so on. It is sometimes supposed that the A.V. represents the latest of the Vedas. This is evidently a misimpression.¹ The truth seems to be that human frailty has always fought shy of the tedious and laborious methods of gaining an object. The spiritual hankering as foreshadowed in the prayers of the *Rik*, and later on so fully developed

"It is well known that not only Indian life with all its social and political institutions has been at all times under the mighty sway of religion, but that we are also led back to religious belief and worship when we try to account for the origin of research in those departments of knowledge which the Indians have cultivated with such remarkable success. At first sight, few traces of this origin may be visible in the *Sástras* of the later times, but looking closer we may always discern the connecting thread."—"Journ. As. Soc." (1875) Vol. XLIV. part i. p. 227.

(1) As Bloomfield remarks:—There is no proof that even the oldest parts of the *R. V.* or the most ancient Hindu tradition accessible historically, exclude the existence of the class of writings entitled to any of the names given to the Atharvan charms.' Intro. to A. V. X. pXX.

in the Upanishads, represents only the aspirations of the few cultured *Rishis*. The bulk of the people have always sighed for a royal road to salvation, hence the necessity for an A.V.; as Emerson appositely says in his essay on Demonology, "the history of man is a series of conspiracies to win from Nature some advantage without paying for it." Atharvanic rites have therefore more or less held sway over mankind in every age and clime. As the Aryan conquerors began to settle in India and came into frequent contact with the aborigines, they had unconsciously to imbibe some of the gross superstitions of the latter, and thus in course of time a superstructure of monstrous growth sprang up, ready to swallow even the purer and more orthodox creed. Hence the protests recorded from time to time in the Mahábhárata and in the law-books against the vulgarity of the aims of the A. V. and the refusal to accept its authority (see *ante* p. viii). But on the other hand, by virtue of its profound hold

upon popular beliefs and because indispersable sciences like medicine and astrology are Atharvanic by distinction, the fourth Veda has always retained a considerable following.¹ If we turn to Europe in the middle ages, we find the professors of the "black art" sharing a fate similar to the priests of the Atharvanic rites,—now openly received into the bosom of the holy church—now anathematised and flung into prison.²

In the Sanskrit Literature whenever there is any reference to sorcery or magic, it is generally laid to the account of the A. V. But in the course of time the worship of Siva came into vogue, which incorporated much that was non-Aryan in character, and which seems to have got blended with A. V.

(1) Bloomfield.—Intro. to *A. V.* xlvi.

(2) This is exemplified in Albertus Magnus and Roger Bacon. The former rose to be a Bishop but "minder glücklich oder unvorsichtiger als Albertus Magnus, entging Roger Baco der Verfolgung als Zauberer nicht. Er wurde in Oxford von seinen eigenen Klosterbrüdern in das Gefängniss geworfen."—*Gesch. d. Chem.*" 1. 63.

rites as modified by changes and requirements of the time. The original inhabitants, "the Dasyus are described in the *Rigveda* as non-sacrificing, unbelieving and impious. They are also doubtless meant by the phallus-worshippers mentioned in two passages. The Aryans in course of time came to adopt this form of cult. There are many passages in the *Mahábhárata* showing that Siva was already venerated under the emblem of the phallus when that epic was composed."¹

Tantric rites
prevalent in the
seventh century.

By the VIIth century A. D., we find Siva's worship well established in India. In the life of King Harsa by Vána there is a graphic description of a weird ceremony performed by a Saiva saint named Bhairavácháryya. "Seated on the breast of a corpse which lay supine, anointed with red sandal and arrayed in garlands, clothes and ornaments, all of red, himself with a black turban, black unguents, black amulet, and black garments, he had

(1) Macdonell : "Hist. Sansk. Lit". p. 153.

begun a fire-rite in the corpse's mouth, where a flame was burning."⁽¹⁾ In the drama of Mālatīmādhava by Bhavabhūti (690 A.D.) we have also references to similar rites.

We have here the outlines of what has been known latterly as the Tantric Cult—a curious admixture of alchemical processes on the one hand, and grotesque and obscene and sometimes revolting rites on the other—all centred round the worship of Siva and his consort Párvatí. The sidelight which is thrown in the life of King Harsa and the graphic account left by his contemporary, the Chinese pilgrim Hiuen Thsang, enable us to draw a picture of N. India in the VIIth century A.D. It has hitherto been taken almost for granted that Buddhism was expelled from India by the persecution of the Brahmins of the Renaissance period. There may have been zealous bigots who now and then went the length of hunting down Buddhists ; but the concensus of testimonies seems to be that both the

(1) Cowell and Thomas' "Trans. of the Harsa-charita p. 92."

people and the princes generally maintained an attitude of philosophic toleration towards the creed of Sákyamuni even so late as the XIth century A.D.¹ The causes which brought about the extinction of Buddhism in India worked from *within*.
 The causes which brought about the extinction The purity of life, and the austerity of practices enjoined on the followers of the creed, become in the long run irksome.

(1) Cf. 'The annual report of the Asiatic Soc. to hand :—

"The copper-plate of Madanapála which has just been referred to is interesting also from a sociological point of view. We know that all the Pála kings were followers of the Buddhist religion, and that it was during their reign that Buddhism flourished for the last time in India. Now the grant recorded in the plate was made by Madanapála to a Brahman as a *dakshina* or honorarium for having read the *Mahábhárata* to the queens of the king's harem. This is one more fact, in addition to others previously known, showing the intimate connexion that existed in the time of those Buddhist kings between Buddhism and Hinduism, a connexion that resulted in the former losing more and more its ground against the latter, and that thus prepared the way for the final destruction of Buddhism by the Muhammedan invaders." p. 26. Similar evidence is also afforded by Raj. Tar. e.g.

"Kalhana does not hesitate to refer repeatedly to the Bodhisattvas or to Buddha himself as the comforters of all beings, the embodiments of perfect charity and nobility of feeling. They are to him beings of absolute goodness "who do not feel anger even

The monasteries degenerated into hot beds of corruption, so much so that the semi-savage Mussulman conquerors felt little compunction of Buddhism. in putting the inmates thereof to the sword.¹ Hinduism also, which has been noted in all ages for its assimilative and elastic character, swallowed up the remnants of the Buddhists by acknowledging the founder of their religion to be an *Avatāra* or Incarnation of Vishnu.

We have seen that the A.V. rites as also the Tantric cults cover almost identical ground; both had their origin in the attempts at popularising the religion among the masses by appealing to the baser or the less refined elements of human nature. An enormous bulky literature has thus sprung up representing this corrupt and effete outgrowth of

against the sinner, but in patience render him kindness.,,—Stein's Intro. p. 8.

(1) According to Waddell, the monks with shaven heads were mistaken for idolatrous Brahmins and massacred wholesale. "Journ. As Soc," LXI. pt. I. p. 20.

Brahminism.¹ There are however two distinct classes of Tantras—Brahminic and Buddhistic—^{Brahminic and Buddhist} dealing in magic, alchemy, sorcery, and allied subjects, which will claim our attention here. The causes which favoured the rise and progress of the Hindu Tantras equally contributed to the development of the Buddhistic,² only in the latter, instead of Siva and Párvatí, a Buddha, a Tathágata or an Avalokitesvara is often addressed in the invocation as the source and fountain of all knowledge. We have also a class of Tantras which is an admixture of Buddhistic and Saiva cult. A notable example of which is afforded by the

(1) Tantras grew up in Kásmir also : "Tantric cult which in Kásmir is still closely connected with Saiva worship, seems also to have been well known to Kalhana." Stein's Intro. to Raj. Tar. p. 80.

(2) Cf. "Pour des esprits grossiers et ignorants, de tels livres ont certainement plus de valeur que les légendes morales des premiers temps du Buddhisme. Ils promettent des avantages temporels et immédiats ; ils satisfont enfin à ce besoin de superstitions, à cet amour des pratiques dévotes par lequel s'exprime le sentiment religieux en Asie, et auquel ne répondait qu'imparfaitement la simplicité du Buddhisme primitif." Burnouf's

Mahákála Tantra.¹ Rasaratnákara, the authorship of which is ascribed to Nágárjuna, also belongs to this category ; this work as well as Rasárnava, a Tantra of the Saiva cult, will claim our special attention, as they embody much valuable information on chemistry.

What is it that made these Tantras the repositories of chemical knowledge ? The answer is given in the words of Rasárnava (lit. sea of mercury) itself, which extols the virtues of mercury and its various preparations :—

“ As it is used by the best devotees for the highest end, it is called *páradā* (quicksilver). ”

“ Begotten of my limbs, it is, O goddess, equal to me. It is called *rasa* because it is the exudation of my body.”

“ It may be urged that the literal interpretation of these words is incorrect, the liberation in this life being explicable in another manner. This

—“Intro a l'hist. du Buddhisme Ind.” p. 466. Regarding Buddhistic Tantras and their relationship to Saiva Tantras, the reader is referred to Burnouf's admirable exposition (*loc. cit.*). See also Barth's. “Religions of India.” p. 201. 3rd ed.

(1) Intro. Hist. Buddh. Ind., p. 480.

objection is not allowable, liberation being set out in the six systems as subsequent to the death of the body, and upon this there can be no reliance, and consequently no activity to attain to it free from misgivings. This is also laid down in the same treatise.

"Liberation is declared in the six systems to follow the death of the body."

"Such liberation is not cognised in perception like an emblematic myrobalan fruit in hand."

"Therefore a man should preserve that body by means of mercury and of medicaments."

A few more typical extracts are given below which will throw further light on the subject :

"The body, some one may say, is seen to be perishable, how can then its permanency be effected? Think not so, it is replied, for though the body, as a complexus of six sheaths or wrappers of the soul, is dissoluble, yet the body as created by Hara and Gaurī under the names of mercury and mica, may be perdurable. Thus it is said in the *Rasahridaya* :—

"Those who without quitting their bodies have attained to new ones through the influence of Hara and Gaurī (mercury and mica), are to be praised as *Rasasūl'ha* (alchemists). All *mantras* are at their services."

“ The ascetic, therefore, who aspires to liberation in this life, should first make to himself a glorified body. And inasmuch as mercury is produced by the creative conjunction of Hara and Gaurí, and mica is produced from Gaurí, mercury and mica are severally identified with Hara and Gaurí in the verse :—

“ Mica is thy seed, and mercury is my seed ;

“ The combination of the two, O goddess, is destructive of death and poverty.”

“ There is very little to say about the matter. In the Rasesvarasiddhánta many among the gods, the Daityas, the Munis and mankind, are declared to have attained to liberation in this life by acquiring a divine body through the efficacy of quicksilver.”

“ Certain gods, Mahesa and others ; certain Daityas, Kāvya (Sukrāchārya), and others ; certain sages, Bālakhilyas and others ; certain kings, Somesvara and others ; Govinda-Bhāgavat, Gōvindanāyaka, Charvati, Kapila, Vyāli and others—these alchemists, having attained to mercurial bodies and therewith identified are liberated though alive.”

“The meaning of this, as unfolded by

Siva to Párvatí, is as follows :—

“The preservation of body, O Supreme goddess! is obtained by mercury and by (the suppression of) breath.¹ Mercury, when swooned, cures diseases and when killed, restores life to the dead. Mercury and air when confined, enable a man, O goddess, to fly about.

“The *swooning state* of mercury is thus described :—

“They say quicksilver to be swooning when it is thus characterised.—

“Of various colours, and free from excessive fluidity or mobility (see p. 74).

“A man should regard that quicksilver as dead, in which the absence of the following properties is noticed.—

“Wetness, thickness, brightness, heaviness, mobility.

“The *fixed* condition is described in another place as follows :—

“The character of fixed quicksilver is that it is :—

(1) Here Cowell and Gough translate पर्ण simply as “air”. We are inclined to think, however, that it is used in the sense of *closing the nostrils*—प्राणायाम of Yoga philosophy.

"Continuous, readily fusible, efficacious, pure, heavy, and that it can revert to its own natural state." Cf. p. 247.

"Some one may urge : If the creation of mercury by Hara and Gaurí were proved, it might be allowed that the body could be made permanent; but how can that be proved ? The objection is not allowable, inasmuch as that *can* be proved by eighteen modes of elaboration. "Thus it is stated by authorities .—

"Eighteen modes of elaboration are to be carefully discriminated."

"In the first place, as pure in every process, for perfecting the adepts."

And these methods of elaboration are enumerated thus.—

"Sweating, rubbing, swooning, fixing, dropping, coercion, restraining."

"Kindling, going, falling into globules, pulverising, covering."

"Internal flux, external flux, burning, colouring, and pouring."

"And eating it by parting and piercing it — are the eighteen modes of treating quicksilver."

"These treatments have been described at length by Govinda-Bhágavat, Sarvajña-rámeśvara and the other ancient authorities, and are here omitted to avoid prolixity.

"By the science of mercury is to be understood not only a branch of chemistry alone, but it is also to be applied to salvation by means of *dehavedha*. Rasárnavá says.—

"You have, O God, explained the killing of metals. Now tell me that process of *dehavedha* by means of which ærial locomotion is effected. Mercury is equally to be applied to metals and body. First make its experiment on metals and then [having thus gained experience] apply it to the body."¹

(1) We have in some places adopted Cowell and Gough's trans. of Sarvadarsanasamgraha, but the rendering appears to be faulty in many instances, notably in the above sloka. The original runs as follows :—

न च रसदात्मं धातुवादावैमेवेति मत्तव्यं देहवेष्टारा सुन्नोरेव परम-
प्रयोगत्वात् । तदुक्तं रसाच्च वे

खोहवेष्टस्या देव यह्नं परमोश्मितः ।

तं देहवेष्टमाच्च येन स्थान् खेष्टरी गतिः ॥

यथा खोहे तथा देहे कर्तव्यः सूतकः सदा ।

Emancipation of a man when alive, as declared in the mercurial system, O subtile Thinker ! is (to be found) in the tenets of other schools though holding different methods of arguments. It is according to all sacred texts to be known by knowledge. None, when not alive, is likely to know the knowable and therefore a man must live (to know the knowable)."

"It is mercury alone that can make the body undecaying and immortal, as it is said :—

"Only this supreme medicament can make the body undecaying and imperishable."

"Why describe the efficacy of this metal ? Its value is proved even by seeing it, and by touching it, as it is said in the Rasárńava :—

"By means of seeing it, touching it, eating it, remembering it, worshipping it and bestowing it

चमानं तु इति देवि प्रत्ययं देहसोहयोः ।

पूर्वे खोहि परीक्षेत पश्चाहेहि प्रयोजयेदिति ॥

I. C. Vidyáságar's Ed. (1858).

Here Cowell and Gough render शातुवाहाणे as "eulogistic of the metal;" and खोह as "blood." Regarding शातुवाहः See p. 191.

npou others, six kinds of highest merits are attained.

"Equal merit accrues from seeing mercury as accrues from seeing all the phallic emblems."

"On earth, those at Kedāra, and all others whatsoever."

"In another place we read:—

"The adoration of the sacred quicksilver is more beatific than the worship of all the phallic emblems at Kāśī and elsewhere."

"Inasmuch as there is attained thereby enjoyment, health, exemption from decay, and immortality."

"The sin of disparaging mercury is also set out:—

"The adept on hearing quicksilver heedlessly disparaged should recall quicksilver to mind."

"He should at once shun the blasphemer, who is by his blasphemy for ever filled with sin."

Cf. under R. R. S. p. 78.

The quotations given above are from the "Sarvadarsanasamgraha," or a "Review of the different systems of Hindu Philosophy" by Mādhavāchārya, prime minister to Bukka I. of Vijayanagara, and who was elected in 1331 A. D. head-abbot of the monastery

of Sringeri. Of the sixteen philosophical systems current in the 14th century during the author's lifetime, Rasesvaradarsana or the "Mercurial System," is one. From the fact that *Rasárnva* is quoted in it as a standard work on this subject it would be safe to conclude that it must have been written at least a century or two earlier, say sometime about the 12th century. In Amarasimha's Lexicon (ca. 1000 A. D.)¹ the following synonyms of *párada* (mercury) are given, namely, *chapala*, *rasa*, and *suta*; but in the vocabulary of *Visvakosha* by Mahesvara (1188 A. D.) *haravíja* (lit. semen of *Siva*) is added thereto. Now in the Tantric literature, of which the philosophy of mercury is the main outcome, quicksilver is regarded as the generative principle, and directions are given for making a mercurial phallus of *Siva*. We may, therefore, take it that the Tantras which deal in mercurial preparations, had their origin sometime about the

(1) Regarding the date of Amarsimha see also p. 146.

11th to 12th century A. D. It would not be justifiable however to hold that the Tantras did not exist before this time.

The age of the
Tantras, dealing
with mercury.

Although we have maintained above that the alchemical Tantras had their origin about the 11th century A. D., it would be safer to conclude that the Tantric processes had sprung into existence long before this time, but that they did not acquire sufficient importance to force the attention of the physicians, as we have seen above that the R. V. and the A. V. existed almost side by side though the latter was held for a long time in contempt and was not quoted in the orthodox treatises.

One very strong argument in favour of much older dates of the above Tantras is that Mádhavácharya, a very cautious and discriminating writer, whom we have quoted above, describes the works he cites, including Rasárṇava, as "ancient authorities" in his

life-time (see above p. lxxvi)

We have already had occasion to draw attention to the non-mention of metallic preparations, notably of those of mercury, in the writings of Vána and I'Tsing (p. li). But this is another apt illustration of the dangers of the *argumentum ex silentio*. In the *Vrihatsamhitá* of Varáhamihira (d. 587 A. D.) there is mention of iron and mercury among the aphrodisiacs and tonics;¹ and this his-

(1) A recent examination of the Sanskrit MSS. in the Durbar Library of Nepal has brought to light important old Tantric works. One, the *Lamkávatára*, a Hindu Tantric work on medicine, written in a later Guṇta hand 908 A. D.); another, "the composition of which must go back to the early centuries of the Christian era." This discovery upsets all established theories as to the age of the Tantras, a full discussion of which must be reserved for the second volume *Vide*.—Rep. on the Search of Sans. MSS. (1895-1900) by M. H. P. Sistri.

(2) रक्तेभिके स्वी पक्षयु यज्ञे नपंतकं शांचितयूकमात्रे
यज्ञात्म यक्षेभिर्दानि निरेभित्तानि इसायमात्र ॥ १ ॥
नान्तीक्षान्तमध्यारदमोऽप्युर्ध्वं-
पश्चामित्तान्तु उहुष्टानि योऽयात् ।
ऐक्षानि वर्गितरहानि जरामित्तान्तिप
सांचितिकोऽपि इमयत्तमां तुर्वा ॥ २ ॥

torical evidence is of great use to us in deciding the age of the Tantras, dealing with mercury.

Contemporary collateral records by foreign writers go to corroborate the date of the alchemical Tantras tentatively fixed by us, as the name and fame of mercurial remedies as used by the Hindu *yogis* had spread far and wide. The following two extracts will suffice:

"There is another class of people called *Chughî* (*yogi*), who were indeed properly Abraiman, but they form a religious order devoted to the idols. They are extremely long-lived, every one of them living to 150 or 200 years. They eat very little
 * * * and these people make use of a strange beverage, for they make a potion of sulphur and quicksilver mixed together, and this they drink twice every month. This, they say, gives them long life; it is a potion they are used to take from their childhood."—Yule's "Macro Polo," Vol. II. p. 300.

"Arghun, der alchymie und den geheimen Wissenschaften ergeben hatte indisehe Bachschi, d. h. Schreiber, gefragt, durch welche Mittel sie

sich ihr Leben so langwierig fristeten. Sie gaben ihm ein aus Schwefel und Merkur zusammengesetztes Mittel als die Panacee der Lebensverlängerung ein." (1290 A. D.)—Hammer-Purgstall; "Geschichte der Ilchane," I. p. 391.

It is to be regretted that of the several Alchemical Tantras works quoted by Mádhava, Rasárnavá alone seems to have survived to our days. This work is almost unknown in Bengal, and extremely rare even in N. India and the Deccan. We have been fortunate enough to procure a transcript of it from the Raghunátha Temple Library, Kásmír, and another from the Oriental MSS. Library, Madras. As one of the earliest works of the kind, which throws a flood of light on the chemical knowledge of the Hindus about the 12th century A. D., Rasárnavá must be regarded as a valuable national legacy. It has, besides, the merit of being the inspirer of several works of the Iatro-chemical period, notably Rasaratna-samuchchaya and Rasendrachintámani. Although Rasárnavá as a Tantra pretends to

have been revealed by the God Siva himself, its author, whoever he may be, now and then blurts out hints, which clearly prove it to have been complied from preëxisting works, for instance, it has not hesitated, as we find ; to borrow copiously from Rasaratnákara attributed to the renowned alchemist Nágárjuna. Of this last work we have been able to obtain as yet only a fragment from the Kásmír Library ; but it has been of signal use to us, as by the parallelism of its text the genuiness and authenticity of a great portion of the Rasárñava have been established.

In the present volume it has been our Collation of MSS. aim to compare and collate carefully the passages in the MSS. of Rasaratnákara, Rasárñava and Rasatnasamuchchaya, in so far as they bear on chemistry and allied subjects ; in this way several important lacunæ have been filled up and many doubtful readings resored. Parallel passages have often been quoted in the foot-notes and cross-

references given, pointing out where the probable borrowing has taken place. It is to be hoped that by instituting this sort of intercomparison, the verbal integrity of the texts adopted may be depended upon, and the danger of interpolation has been avoided. The texts of Charaka, Susruta, Vágbhata and Chakrapani have not been reproduced as they are available everywhere in the most reliable shape.

The translations presented do not always Recommendatory features of R. R. S. pretend to be strictly literal, and we hope the indulgent reader will put up with infelicities of expression here and there, which could not be avoided without taking undue liberty with the original. We have drawn very largely upon R. R. S., because it has several features to recommend. First, an excellent edition of it has been published at Puna, based upon a comparison of 13 MSS., procured from different parts of Southern India. Second, there exists a Ms. of it in the library of the Sanskrit College, Benares, in a very neat and

legible handwriting, copied in samvat 1850 i. e. 1793 A.D., to which we have had access whenever required. We have also obtained a transcript of it from the Kásmír Library. The Benares and the Kásmír MSS. agree in all essentials, but differ in certain places from the Puna edition. The text we have adopted is thus based upon a comparison of the Deccanese and N. Indian exemplars. Third, while Rasaratnákara and Rasárñava are Tantras pure and simple in which alchemy is incidentally dwelt upon, R. R. S. is a systematic and comprehensive treatise on *materia medica*, pharmacy and medicine. Its methodical and scientific arrangement of the subject-matter would do credit to any modern work, and altogether it should be pronounced a production unique of its kind in Sanskrit literature. Its value is further enhanced from the fact that the *materia medica* portion is harmoniously blended with chemistry.

The author, whoever he may be, is very pseudo-Vágbhata. anxious to establish his identity with Vágbhata,

the celebrated author of the *Aśtāṅga* and describes himself as such in the colophons at the end of every chapter (p. 78); but he forgets that in doing so he is guilty of a glaring piece of anachronism. The chemical knowledge, as revealed in the *Vāgbhaṭa*, is almost on a par with that in the *Susruta*. But this sort of utter disregard for chronological accuracy is by no means uncommon in the alchemical literature of the middle ages in Europe. The world is indebted to the genius and perseverance of M. Berthelot for unravelling the mysteries which so long hung about the writings of Geber¹⁾; and the interval of time between our pseudo-*Vāgbhaṭa* and the author of *Aśtāṅga* is even much wider than that between the Latin Geber and the real Geber. We are apt to be very harsh

1)) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIII^e siècle, et l'a mis sous le patronage du nom vénéré de Géber; de même que les alchimistes gréco-égyptiens avaient emprunté le grand nom de Démocrite pour en couvrir leurs élucubrations."—"La Chimie au Moyen Âge, T. I. p. 349.

on these literary forgerers ; rather we ought to give them credit for their utter self-effacement. We often forget that the spirit of the times in which they wrote was dead against them—reluctant to accept revolutionary ideas or discoveries ; hence the temptation to fasten them on old and recognised authorities.

Although no direct historical evidence is available, we are not left entirely in the dark. Our author, at the very outset, names twenty seven alchemists from whose writings he derives his materials (p. 77), and later on, in the section on apparatus (p. 130), he quotes Rasárnava as a source of his information. Opium was not employed in medicine in his time nor is there any mention of Phiraṅgaroga, (lit. the disease of the Portuguese),¹ which was introduced into India about the middle of the 16th century, and the treatment of which by means of calomel and *chob-chini*

Probable date of
R. R. S.

(1) This is the name by which syphilis is known in the later Hindu medical works. See p. 252.

(China root) occupies a conspicuous place in
in the much later work, *Bhīvaprakāśa*. The
date of the R. R. S. may, therefore, be
placed between the 13th and 14th centuries
A. D.

CHAPTER V

IATRO-CHEMICAL PERIOD

During the Tantric period, with its system of the "Philosophy of Mercury" a vast mass of chemical information was accumulated, which was pressed into signal service in the period immediately succeeding it—the Iatro-chemical Period of India. The prominent feature of the former lies in the search after the *elixir vitae* and the powder of projection as the contents of the *Rasaratnîkara* and *Rasârnava* amply testify; whereas in the latter these phantastic and extravagant ideas, impossible of realisation, had subsided into something more practical and tangible. The numerous preparations of mercury, iron, copper and other metals, although they could not secure immortality or revive the dead, were found to be helpful accessories in medicine. At first they came

Characteristics of
the intro-chemical
period.

to be used cautiously and tentatively, mixed up with the recipes of the Charaka and the Susruta, which are drawn chiefly from the vegetable kingdom; but they soon began to assert a supremacy of their own and even to supplant the old Ayurvedic treatment by herbs and simples. Nay more, absurd pretensions were set up on behalf of these metallic preparations. Thus in Rasendrachintámani, a work probably co-eval with R. R. S., we come across this remarkable passage :— “Revered teacher! be pleased to instruct me, for the benefit of the weak and the timid, in a mode of treatment which will dispense with the use of the lancet, and both active and potential cauteries,” thus putting in a plea for the indiscriminate use of mercurial remedies.

R. R. S. is a typical production of the latro-chemical period. The name of treatises treating of medicinal chemistry is simply legion. But they are all cast in the same mould, and the close similarity of their contents would render their translation only a

works of supererogation. We have, therefore, confined ourselves to quoting only such parallel passages in the foot-notes as are calculated to throw light upon or corroborate the authenticity of, the text of R. R. S.

An account of this period will be scarcely complete, which fails to take Nágárjuna. note of the conspicuous figure whom the Indian alchemists unanimously look upon as the inventor of the processes of distillation and calcination—the renowned and the venerable Nágárjuna, the reputed author of *Kakshaputatantra*, *Rasaratnákara* and *Arogyamañjarí*, etc. Our R. R. S., in the opening lines, invokes him as one of the 27 alchemists, and in the chapter on minerals quotes him as an authority. So does Rasendrachintámani as also Chakrapáni while describing the process of roasting iron (p. 62).

We have already seen that according to Vrinda and C. p., Nágárjuna was the first to introduce the preparation known as Kajjvali (black sulphide of mercury p. 61). Dalvana also makes him the redactor of the *Susruta*.

The mention of Nágárjuna by all these authorities would not remove him far from the 8th or the 9th century A. D., a date which is also confirmed by Albérúní, who says :

"A famous representative of this art [alchemy] was Nágárjuna, a native of the fort Daihak, near Somnáth. He excelled in it and composed a book which contains the substance of the whole literature on this subject and is very rare. He lived nearly a hundred years before our time." —'India, I. p. 189.

But there are difficulties in the way of accepting this chronology of the age of Nágárjuna. Hiouen Thsang, who resided in India from 629 A. D. onwards, relying upon local traditions, speaks of Nágárjuna.¹ as a

(1) "Nagarjuno Bodhisatva was well practised in the art of compounding medicines, by taking a preparation (pill or cake) he nourished the years of life for many hundreds of years, so that neither the mind nor appearance decayed. Satváha-rája had partaken of this mysterious medicine."—Beal's Buddhist Records of the Western World, vol. II, p. 212.

Again Then "Nágárjuna Bodhisatva, by moistening all the great stones with a divine and superior decoction (medicine or mixture) changed them into gold." —*Ibid.* p. 216.

learned and revered Buddhist and alchemist, and a friend of King Satváhana.² The poet Vána, a contemporary of the Chinese pilgrim, also corroborates this account in his life of King Harsha.

In the Buddhist canonical literature, Nágárjuna is a prominent figure as the founder, or, at any rate, the systematiser of the Mādhyamika philosophy. Western scholars maintain that he lived in the 1st century A.D., while according to Rájataranínginí, the "History of Kasmír" by Kalhana Misra (11 century A. D.), Nágárjuna flourished 150 years after Sakyasimha had betaken himself to asceticism, i.e. he lived in the last quarter of the 4th and first quarter of the 3rd century B. C. It is doubtful, however, if Nágárjuna, the philosopher, is the same as Nágárjuna, the alchemist, considering

(2) Nágárguna was a friend of Satváhana, a king of Kosala country to the South West of Urisya and watered by the upper feeders of the Mahánadî."—*Ibid.* II. p. 209. As to the age of Satváhana see Burgess' Archaeological Survey of S. India. Regarding Nágárjuna see also Introd. à l' histoire du Buddh. Ind. p. 508.

that we find no reference whatever to the processes of distillation, sublimation etc. in the Charaka, the Susruta, and the Vāgbhata, though it must be admitted that the latter can lay claim to superior chemical knowledge. (see p. xlvi).

We have also another alchemist in Patañjali, who is better known as Patañjali, the commentator of Pāṇini. He probably lived in the 2nd century B. C.¹ Sivadāsa, in his commentary of Chakrapāni, quotes him as an authority on Lohasāstra, or the "Science of Iron," and Chakrapāni himself speaks of him as the redactor of Charaka (see p. xv). Bhoja in his Nyāyavārtika speaks of Patañjali, as a physician both to the mind and to the body.² The moksha (salvation), as taught in the Yoga system of Patañjali, is

(1) Proof Bhandarkar Ind. Antiquary, 1872, pp. 299-302.

(2) "योगेन चित्तस्य पद्मेन बाधां मनं श्रीरम्य तु वैद्यनेन ।
योऽपाकरात् तं प्रवरं सुनोमां पतञ्जलिं प्राञ्छिरामतां इति ॥"

—Bhoja. Nyāyavārtika, quoted by Sivarāma, the commentator of Vāśavadatta.

also connected with alchemy.³ We have already seen, while discussing the "Philosophy of Mercury" (see *ante p.* lxxvi), the Rasáyana or Alchemy was simply regarded as a means to an end—as a path leading to moksha. It is significant that this connection can be traced from so early a date.

In the present volume we shall seldom have occasion to go beyond the 14th century A. D. It will, perhaps, add to the interest of the subject, if we turn our eyes for a moment to the progress of chemical knowledge in Europe at that time, and the alchemical ideas and beliefs dominating it. Contemporary with the authors of Rasárnava and Rasartnasamuchchaya, were Roger Bacon (d. 1294), Alertus Maguns, Raymond Lully, and Arnaldus Villanova. Roger Bacon does not hesitate to assert that the philoso-

(3) The author (Patañjali) adds to the three parts of the path of liberation a fourth one of an illusory nature, called Rasáyana, consisting of alchemical tricks with various drugs, intended to realise things which by nature are impossible."—Albérün's 'India'—I. p. 85

pher's stone was able to transform a million times its weight of base metal into gold. The above-named alchemists are also unanimous in regarding it as a universal medicine, and "it was no unusual assertion that adepts, the fortunate possessors of the panacea, had been able to prolong their lives to 400 years and more."—Meyer. The readers of Rasárnava and the other Tantras will not fail to find that there is much in common between the Hindu alchemists and their European *confrères*.

The knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps earlier, such as we are enabled to glean from Rasárnava and similar works, is distinctly in advance of that of the same period in Europe. It was known for instance that blue vitriol and a variety of the pyrites (see p. 70) yielded an essence in the shape of copper; and calamine, zinc. The colour of flames as a

Knowledge in practical chemistry, prevalent in India in the 12th and 13th centuries A. D., and perhaps earlier, such as we are enabled to glean from Rasárnava and similar works,

diagnostic test of metals was well understood (p. 68). The metallurgical processes, described under the latter, leave little to improve upon (p. 88), and, indeed, they may be transferred bodily to any treatise on modern chemistry. Even Paracelsus, who flourished some three centuries later, leaves us in the dark as to the nature of his 'zinken,' which he designates a 'semi' or 'bastard' metal. And Libavius (d. 1616) "who stood up manfully against the excesses of Paracelsus, and who vigourously combated the defects in his doctrines, * * * and the employment of "secret remedies," believed in the transmutation of the metals and the efficacy of potable gold.¹ It is not necessary to pursue this subject further here, as details will be found in the chapter on metallurgy (pp. 152-169).

The truth is that up till the time to pseudo-Basil Valentine (ca. 1600 A. D.),

(1) *Geschr. d. chem.* I. 13.

very little scientific progress was achieved in Europe. The doctrines of Aristotle and of the Arabian alchemists held the ground, and the enigmatic and mystic language, which was often used as a cloak for ignorance, simply confounded the confusion.

Still more solid progress was effected in pharmacy. For two thousand years or more the Charaka and the Susruta have been paid all the honours of a state-recognised Pharmacopœia. Partly due to their being regarded as of revealed origin, and partly due to that veneration for the past, which is inherent in the Hindu, the text of the above works has seldom been allowed to be tampered with. A critical examination of the Bower Ms. such as we owe to Dr. Hoernle, shows that the recipes of several important preparations agree in all essentials, and sometimes word for word, with those of the Charaka and the Susruta of the existing recensions (see *ante* p. xix). Mr. Ameer Ali is scarcely correct when he claims that "the Arabs invented chemical pharmacy, and were the founders of

those institutions which are now called dispensaries.'¹

We have only to refer our reader to the chapter on the preparation of caustic alkali, in the *Susruta*, with the direction that the strong lye is to be "preserved in an iron vessel," as a proof of the high degree of perfection in scientific pharmacy achieved by the Hindus at an early age (p. 37). It is absolutely free from any trace of quackery or charlatanism, and is a decided improvement upon the process described by a Greek writer of the IXth century, as unearthed by M. Berthelot.² As regards *dispensaries* and hospitals, every one knows that Budhistic India was studded with them (*vide* p. xxxii).

Speaking of the progress of chemistry in Europe in the XVIth century, Prof. Schorlemmer remarks :—

"Up to the XVIth century almost the sole object of chemical research had been to find the

(1) *Hist. of the Saracens*, p. 462, (Ed. 1899.)

(2) See p. 22.

philosopher's stone. But now chemistry began to develop itself two new and different paths, opened by two distinguished men—Agricola, the father of metallurgy, and Paracelsus, the founder of Iatro-chemistry or medical chemistry. Both contributed chiefly to the development of inorganic chemistry * * * In opposition to the school of Galen and Auicenna, Paracelsus and his followers chiefly employed metallic preparations as medicines." 1

Udoy Chand Dutt, in the preface to his *Materia Medica of the Hindus*, states :—

"The oldest work, containing a detailed account of the calcination or preparation of the different metals (such as gold, silver, iron, mercury, copper, tin and lead) for internal use with formulae for their administration, is, I believe, a concise treatise on medicinal preparations by Sārngadhara.

This is evidently a mistake. Sārngadhara is simply a compilation based upon the Charaka and the Susruta on the one hand, and the Tāntric works described above on the other. It cannot be regarded as going beyond the latter part of the 14th century, and

(1) *Rise and development of Organic chemistry* (ed. 1894)

it will come under our notice in the second volume of the present work. In the European histories of chemistry, the credit of being the first to press chemical knowledge into the service of medicine and introduce the use of the internal administration of mercurial preparations, is given to Paracelsus (1493-1541). The Nágárjunas and the Patanjalls of India, however, had the merit of anticipating Paracelsus and his followers by several centuries. The earliest historical record of the internal use of black sulphide of mercury, dates so far back as the 10th century A. D. at the latest¹ (see *ante* p. 59). We have indeed, reasons to suspect that Paracelsus got his ideas from the East, and in Chapter on *Arabian indebtedness to India* we have pointed out the media through which Indian sciences filtered into Europe.

(1) In Europe, its use dates from the 17th century. "Das schwarze Schwefelquicksilver lehrte zuerst Furquet de Mayerne im Anfange des 17. Jahrhunderts, durch Zusanmmenreiben von warmen Quicksilber mit geschmolzenem Schwefel darstellen." Kopp. Gesch. 186.

Dutt says : " We cannot help admiring the ingenuity and the boldness of the Hindu physicians, when we find that they were freely and properly using such powerful drugs as arsenic, mercury, iron, etc., when the Mussulman Hakims around them with imperial patronage and the boasted learning of the West, recording such remarks regarding them as the following :—

' Soomboolkhar, 'the white oxide of arsenic.—' There are six kinds of this, one name Sunkia, the third Godanta, the fourth Darma, the fifth Huldea. The Yunāni physicians do not allow this to form a part of their prescriptions, as they believe it destroys the vital principle. The physicians of India, on the contrary, find these drugs more effectual in many disorders than others of less power such as the calx of metals. For this reason too I am in the habit of seldom giving these remedies internally, but I usually confine my use of them to external application and as aphrodisiacs which I prescribe to a few friends, who may have derived no benefit from Yunāni prescriptions. It is better to use as few of them as possible." ¹

" Pārā, 'Mercury.'—It is very generally used throughout India in many ways, both in its native

(1) Taleef Shareef trans. George Playfair, p. 99.

and prepared state, but in the latter we ought to be very cautious, for it is seldom sufficiently killed or removed from its native state, in which it is a dangerous drug.”¹

“Loha, ‘iron.’—It is commonly used by physicians in India, but my advice is to have as little to do with it as possible.”²

Nor must we forget that so late as 1566 A. D. the Parliament and the Faculty of medicine, Paris, condemned and forbade what was regarded as the dangerous innovations of Paracelsus.³

Apart from the historical data already adduced, the above extracts from a Mohammedan writer would show that the Hindus were perhaps the earliest in the field to advocate the internal use of mercury.¹ Ainslie, in a note appended “Lepra Arabum,” written in the early part of the last century, thus expresses his views on the subject:—

(1) *Ibid.*, page 26.

(2) *Taleef Shareef*, page 146.

(3) *Gesch. d. Chem.* I, 110.

note appended to "Lepra Arabum," written in the early part of the last century thus expresses his views on the subject :—

"It is well known that the Eastern nations were the first who employed mercury in the cure of obstinate, cutaneous and leprous affections; and it may be questioned whether the natives of India were before the Arabian or only second in order in availing themselves of the virtues of that powerful mineral. Rhazes,¹ Mesu and Avicenna² all notice it, and according to Fallopius, as we find observed by Le Clerc in his "Histoire de la Médecine" pp. 771-791, it was the opinions of those writers which first suggested its use in venereal diseases.³

(1) "Argentum vivum cum extinguitur ardens est, quod scabei, et pediculis auxilium offert"—Rhazes "de Re med." (lib iii cap. xxiv). In the days of Pliny the Elder the medicinal virtues of mercury do not appear to have been at all ascertained; that writer termed quicksilver the bane and poison of all things and what would with more propriety be called *death* silver. "Nat Hist." lib xxxiii. Cap. vi).

(2) Avicenna says of mercury "argentum vivum extinctum adversus pediculos et lentes cum rosaseo oleo valet" *Vide* lib. ii. tract. ii. p. 119.

(3) Trans. R. As. Soc. (1824-27).

From the evidences we have adduced all along there can now be scarcely any question as regards the priority of the Hindus in making mercurial remedies a speciality; and they are entitled to claim originality in respect of the internal administration of metals generally seeing that the Charaka and the Susruta, not to speak of the later Tantras, are eloquent over their virtues.

CHAPTER VI.

Indebtedness of the Arabians to India.

The Arabians are acknowledged on all hands to have played a prominent part in the propagation of science and mathematics in the West. When in the dark and middle ages, the lamp of knowledge had begun to burn very low in Europe and even when the very vestiges of Greek culture and learning had all but disappeared, save in the obscure and dingy cells of the monk, it was the Arabs who carried there the accumulated intellectual treasures of the East, and thus laid the foundation, so to speak, of modern European greatness.

It will, perhaps, be not out of place to discuss here briefly as to how much India indirectly contributed to this result in the departments of medicine, pharmacy and other kindred subjects.

The author of *Kitāb-al-Fihrist*, who wrote towards the middle of the tenth century¹, Haji Khalifa and Ibn Abú Usaibiah, who flourished at the commencement of the 13th century, distinctly mention that by order of the Caliphs Harun and Mansur several standard Hindu works on medicine, *materia medica* and therapeutics were translated into Arabic. The information on the subject has been gathered at length by Dietz in his *Analecta medica*, Wustenfeld, author of *Geschichte der Arab. Aerzte*, Cureton², Flügel, Müller and other Arabic scholars.

(1) "Abu'l Faraj Mohammed bin Ishak, surnamed au-Nadim, a native of Bagdad, first conceived the idea of a bibliographical dictionary. His *Kitāb-al-Fihrist* deals with every branch of learning. It gives the names of many authors and their works which have ceased to exist."—*Hist. of the Saracens* by Ameer Ali, p. 469.)

(2) Prof. H. H. Wilson in a *Note* appended to a paper by the Rev. W. Cureton entitled "A collection of such passages relative to India as may occur in Arabic writers" thus pithily summarises his own views:—"In medicine the evidence is more positive, and it is clear that that the *Charaka*, the *Susruta*, the treatise called *Nidána* on diagnosis, and others on poisons, diseases of women and therapeutics, all familiar to Hindu Science, were translated and studied by the Arabs in the days of

Flügel¹ states on the authority of *Kitāb-al-Fihrist* that *Susrud* (the Sanskrit name Susruta, thus corrupted into Arabic) was translated by Mankh, the Indian, who cured Harun ar-Raschid of a severe illness, and was appointed physician in charge of the Royal Hospital. We also learn that a work on the official plants of India was rendered into Arabic by the same Mankh. The other comprehensive Sanskrit treatise, the Charaka was also fully laid under contribution.

We have ample and overwhelming testimony of Arabic writers, notably of Haji Kha-lifa, that Hindu astronomy, algebra and medicine were zealously studied by their compatriots, and many Hindu servants were induced to reside at the Court of the Caliphs as their instructors. Mussulman students,

Harun and Mausur, either from the originals or translations, made at a still earlier period, into the language of Persia."—*Journ. Royal Asiatic Soc.* old series, vi. pp. 105-115.

(1) "Zur Frage über die ältesten Uebersetzungen indischer und persischer medicinischer Werke ins Arabische: Ziet. deut. morg. Ges. xi. pp 148 and 325.

in their eager thirst for knowledge, used to flock to the centres of learning in India, and there drank deep at the very fountain-head. Indeed, it had come to be regarded as an essential part of completing one's liberal education to travel to India and learn the sciences firsthand.

That this is no language of rhetoric will be evident from the extracts quoted below from Gildemeister's "Scriptorum Arabum De Rebus Indicis loci et opuscula."

"Etiam Muhammed ben Ismaïl al Tanûkhi in Indiam profectus est eo imprimis consilio, ut Indorum astronomiam cognosceret.

"Ibn Albaithâr, rei herbariae inter Arabes peritissimus, qui and eius disciplinae studium longe inqua itinera per Hispaniam Africam et Asiam instituit, etiam in Indiam venit, teste Leone Africano; Abulfadâ tamen et Ibn Abi Ucaibia, qui de eius vita scripserunt, eius rei mentionem non faciunt."
p. 80.

"Sed etiam accuratius edocti erant, et scite iam vetus Indopleusta eas disciplinas, in quibus Indi maxime excellerent, nominat has: medicinam, philosophiam et astronomiam. Eodem modo Hagi

Khalfa arithmeticam, geometriam, medicinam, astronomiam et metaphysicam enumerat." p. 81.

"De libris ex Indica lingua in Arabicam conversis iam inter Arabes egerunt ii, qui libros de re literaria composuere. Plurimi de iis sine dubio apud Hag'i Khalfam legentur, cuius hucusque pars tantum publico usui patet. De antiquioribus his libris locuples testis est antiquissimus de Arabum literis scriptor Ibn Abi Yaqub ibn Alnadim, qui in *Indice scientiarum* * * * * * quem scripsit anno 337 (inc. 10 Jul. 948) inter monumenta literarum Arabicarum etiam peculiari cura egit de libris e linguis Graeca, Persica et Indica conversis." p. 82.

Haas, whose criticism of the Susruta we have already noticed, having Müller's refutation of Haas. once taken up the position of denying the antiquity of Hindu medicine with special regard to the Charaka and the Susruta, was driven to the necessity of discounting, nay, explaining away, the numerous references to Hindu works made by Mussulman writers. This had the effect of eliciting a reply from Müller, who subjected the Arabic literature bearing on the subject to a

crucial examination, especially Book XII of Useibia. He finds that not only the Charaka and the Susruta, but also the Nidána and the compendium Asánkar,¹ a book on Poison by Sánáq the Indian, and another on Warm and Cold, and several other works were rendered into Arabic. This German orientalist also arrives at the conclusion that Indian physicians practised at the Court of Bagdad.²

We have now to place before the reader the Albérúní's evidence of a remarkable author —remarkable alike for the depth of his learning, versatility of his genius, rare impartiality of his judgment and his singular freedom from race-bias.

Albérúní lived in India from 1017-1030 A. D., and during this long sojourn he mastered Sanskrit and studied Hindu mathema-

(1) A Variant has "Astankar," which will be readily identified as the *Astánga of Vágbhata* (see p. xlvi.)

(2) "Schon vor Er-Rasid, vielleicht sogar gleichzeitig mit dem Uebergange indischer Astronomie nach Bagdad.....haben sich auch indische Aerzte in Bagdad eingefunden." (Loc. cit. p. 499). "Arabische Quellen zur Geschichte der indischen Medizin."—"Zeit, deut, morg. Ges. 34, p. 465."

tics and philosophy in the original.. At a time when his patron, Sultan Mahmud of Ghzni, was busy pillaging the temples in Thaneswar, Mathura, Kanauj and Somnath with the zeal of an iconoclast, this philosophic Moslem was pondering over the Sámkhya and the Pátañjala, and instituting a comparison between their contents and those of the "Timæus" and its commentator, Proclus.

We have elsewhere quoted at length Albérúní's views on Rasíyana (alchemy); it now remains for us to glean such information from him as will throw light on the subject under inquiry. According to Sachau, the learned translator of Albérúní, "some of the books that had been translated under the first Abbaside Caliphs were extant in the library of Albérúní, when he wrote his India, the Brahmasiddhánta or Sindhind.....the Charaka in the edition of Ali Ibn Zain and the Pañctantra or Kalila and Dimna." The fact that the Charaka occupied a place in the library of a cultured Arab affords an additional proof of the esteem in which the Hindu system of

medicine was held by the Moslem world. We also learn that "the Christian philosopher and physician from Bagdad, Abulkahir Alkhamnour, friend of Albérúní, seems to have practised in Ghazni his medical profession" (Sachau). This is significant as indicating that both the Greek and Hindu systems held sway side by side ; but more of it anon.¹

So far as regards historical evidence. Let
 Internal evi- us now see if any internal evi-
 dence dence could be gathered in cor-
 roboration of the former. Reference has
 already been made to the Book on Poisons
 by Sānāq the Indian. We shall cite here
 some parallel passages on the Examination
 of Poisoned Food and Drink. These are
 the chief characteristics as given by Sānāq,
 the Charaka and the Susruta respectively.

(1) "Dietz also in his *Analecta Medica* proves that the later Greek physicians were acquainted with the medical works of the Hindus, and availed themselves of their medicaments ; but he more particularly shows that the Arabians were familiar with them, and extolled the healing art, as practised by the Indians, quite as much as that in use among the Greeks."—Royle : " *Antiq. Hind. Med.*" p. 64.

SANAQ THE INDIAN

THE CHARAKA

THE SUSRUTA

The vapor emitted by poisoned food has the colour of the throat of the peacock . . . when the food is thrown into fire, it rises high in the air; the fire makes a crackling sound as when salt deflagrates . . . the smoke has the smell of a burnt corpse. Poisoned drinks: butter milk and thin milk have a light blue to yellow line.

The food is to be thrown into fire for testing . . . the flame becomes parti-coloured like the plume of a peacock. The tongue of the flame also becomes pointed; a crackling sound is emitted and the smell of a putrid corpse is perceived. . . . Water, milk and other drinking liquids, when mixed with poison, have blue lines printed upon.—“Chikitsá,”

Ch. xxiii, 29-30.

When poisoned food is thrown into the fire, it makes crackling sound and the flame issuing therefrom is tinted like the throat of the peacock.—“Kalpa,” Ch. i, 27.

The physician, as superintendent of the kitchen, well-versed in toxicology, is essentially an Indian institution. Cf. Susruta, Kalpa, Ch. I. 6-9

Müller has pointed out the parallelism as shown above. We have, however, added to it the diagnostic test of poisoned food as

given in the Charaka, and it will be seen that Sānāq was equally indebted to this authority and to the Susruta.

The description of leeches as given by Rases agrees almost word for word with that of the Susruta (Sanasrad) in many places.

SUSRUTA

The variety of leeches called *Krishnā* is black in colour and have thick heads, *Karvurās* have their bodies, like that of eels with elevated stripes across their abdomen. *Alagardhās* have hairs on their bodies, large sides and black mouths, *Indrāyudhās* have longitudinal lines along their back, of the colour of the rainbow.

RASES, QUOTING SANASRAD

Of the leeches one is poisonous, which is intensely black like antimony having a large head : and scales like certain fishes and having the middle green : also another upon which are hairs, has a large head and different colour like the rain-bow.

Sāmudrikās are of a dark-yellow colour and have variegated spots on their bodies resembling flowers in appearance. *Gochondanās* have bifurcated tails like the two horns of a cow and small heads. When these poison-

ous leeches bite any person, the bitten parts become swollen and very itchy, and fainting, fever, burning of the body, vomiting, mental derangement and langour occur. in these cases the medicine called *Mahāgada* should be administered internally, applied externally and used as snuff. The bite of the leech called *Indrā-yudha* is fatal. Such is the dsscription of the poisonous leeches, and their treatment.

Now the non-poisonous leeches. Their names are as follows : *Kapilā, Pingalā, Sankumukhi, Mūshikā, Pundarikamukhi and Sāvarikā*

in the colour of which there are lines as in blue-spar, bluestone, azure—which often bites : thence will be caused abscess with fainting : with coma and relaxing of the joints : nevertheless of these very leeches thcre is a good one which is assimilated to the colour of water :

Kapilā have their sides of the colour of orpiment

in which there will be greenness having upon it two lines like arsenic [orpiment] but light red,

and
their back smooth and of the colour of the pulse called

mudga (Phaseolus mungo).

Fingalas have round bodies, move quickly, and are of slightly red or tawny colour. Sāṅkuhmukhis are liver-coloured, suck blood quickly, and have large sharp mouths.

pay

coloured and corresponding to the colours of liver : which are swift to draw to themselves fine blood :

Mushikas have the colour and shape of rats and a bad smell.

which are assimilated to the tail [colour] of a mouse : having a horrible smell * * *

Pundarikās have mouths like the lotus and are of the colour of the pulse of *Phaseolus mungo*. *Sāvarikās* have green colour like the leaf of the lotus, are functuous, and eighteen fingers in length. They are used only for extracting blood from beasts. Such is the description of the non-poisonous leeches. The non-poisonous jeeches are found in Turkey, *Pāndya* (the country to the south), *Sahya* (a mountain on the banks of the *Narbadā*)

And having the belly red along with blackness

and *Pautana* (the tract of country about Mathuro). Of non-poisonous leeches, those which are stronger and have large bodies, can drink blood rapidly and eat much, are especially free from poison.

Leeches which are produced in dirty water and from the decomposition of poisonous fishes, insects, frogs, urine and faeces are poisonous. Those produced in pure water and from the decomposition of the different varieties of the *Nelumbium Speciosum* and the *Nymphaea lotus* and of *Sairāla* (*Blyxa o. tandra*) are non-poisonous.

The varieties of *Nymphaea* mentioned here are *padma*, *utpalā*, *kumuda*, *nalina*, *kuvalaya*, *saugandhika* and *pundarka*.

On this subject there is the following verse :—Non-poisonous leeches go about in the field and fragrant water. They do not live in confined

and the back green : they are

bitter but they will be worse in bad water quite stagnant in which are many small tadpole frogs : nevertheless, they are good in good and excellent water,

places or lie in mud as they seek comfort. These should be caught by means of wet-leather or some other article. They should be kept in a new large earthen pot filled with mud and water from a tank. Mosses, dried flesh and powdered tubers of water-plants should be given them for food. For bedding they should be furnished with grasses and leaves of water-plants. Fresh water and food should be given every second or third day, and every seventh day the earthen pot should be changed. On the subject there is the following verse :

Leeches which are very thin or thick or with their central portions thick, which move slowly or do not stick to the part to which they are applied, which drink little blood, or which are poisonous, are not fit for use. When about to apply leeches on a person who has got a disease curable by them, the patient should be made to sit or lie

also when they are seized or caught, let them be put away while all that which is in their own belly is being purged : also they ought not to be put on except in a place not healthy :

down. The affected part, if free from pain, should be rubbed with a little cowdung and earth. The leeches should then be taken hold of and smeared with a mixture of turmeric and mustard reduced to a paste with water. They should then be placed for a while in a cup of water, till they are relieved of their weariness and afterwards applied to the diseased part. *When being applied, their mouths should be left open and their bodies covered with fine white wet rags.*

If they do not bite, a drop of milk or blood should be applied to, or a small incision may be made on the diseased part. If even by these means a leech cannot be applied, it should be changed for another.

A leech is known to have fixed itself to the part when it raises its shoulder and bends its head like a horse-shoe. When fixed it should be covered

also anointments ought to be made around the place with paste that they may not touch the healthy place: also as often as leeches are applied, put over them a fine soaked cloth:

If a leech does not stick let the place be anointed with milk or with blood: if it still refuses to bite, let another be applied in the place of it:

with a piece of wet cloth and a little water sprinkled on it occasionally. If the part bitten by a leech itches or is painful, it is a sign that the leech is drawing pure blood and it should be removed from the part.

*If from fondness for blood
it cannot be readily remov-
ed, a little rock-salt should
be sprinkled on its head. ‡*

*but if
you wish that they fall off,
sprinkle their heads.(mouths)
with salts and keep them in
a jar. †*

There is thus unmistakable evidence here of the use of a chapter of the Susruta or some such work.

Then again several drugs, which are repeatedly mentioned in the Charaka and are almost exclusively Indian products, have been borrowed in the *materia medica* of Useibiah

‡ Dutt's Trans.

† The version of Rases, being in the "dog" Latin of the middle ages, is not always very intelligible to us.

and others. The following may be taken as examples : Pepper,¹ lac, nard,² liquorice, assafœtida qccimum, sanctum, bdellium, cinnamon, the chebulic myrobalans, calamus acorus, agallacha,³ berberis asiatica,⁴ myrrh, melia azadirechta, calotropis, (asclepias), and red sandal. To quote Gildemeister :

“ Ex. hac Indiae parte asportatur agallochum Kumārense, quod inde nomen cepit.” p. 156.

(1) Dioscorides also mentions the three peppers. Arabian physicians of the tenth century also describe their properties. See Dymock, Warden and Hooper's “ Pharmacographia Indica,” III. pp. 176-185.

(2) “ Nardostachys jatamansi,” the Nardin of Dioscorides, called also “ Gangitis,” because the Ganges flowed from the foot of the mountains where the plant grows : *ibid* II. p. 234.

(3) For the discussion of agallocha (sans. अग्लोचा), see also “ Script. arab. de Reb. Ind.,” pp. 65-72.

(4) The extract of the wood was also known to the Greeks under the name of Indian Lycium. “ Pharm. Ind.,” I. 65.

Cf. “ Among the strictly Indian products, we have the two kinds of Pepper (long and round), Cardamoms and Ginger (?) the “ Dolichos,” mentioned by Hippocrates and Theophrastus, as well as by later authors, is considered to be “ Phaseolus Vulgaris, and to have been introduced from India in the time of Alexander.” Royle: “ Antiquity of Hindu Med.,” Lond., 1837, p. 121.

"Abuldhali Sindius dum Indiae regiones describit, dicit :

' Negarunt quidem sodales mei nec tamen istud praestantissimum est.

"Quando laudabatur India Indaque sagitta in campo caedis.

" Per vitam meam ! terra est : in quam si pluvia decidit.

"Contingunt hyacinthi et uniones ei qui monilibus caret.

" Ibi originem habent muscus et camphora et ambarum et agallochum

" Et aromatum genera, quibus utuntur qui inodori sunt.

' Et odoramentorum species ,et myristica et spica nardi ;

' Ibi ebur et tectonae lignum, ibi lignum aloës et santalum

" Ibique est tutia montis instar longissimi."

pp. 217-218.

That the Charaka should be changed by Arabic writers into "Sarak," Susruta into "Susrud," Nidána into "Badan," Astánga into "Asankar" and so forth, need not at all surprise us. Such transformations can well be explained on phonetic principles. Moreover,

one must remember that the Indian works translated into Arabic were sometimes derived from preexisting Phelvi versions, and in the migrations through successive languages, the names often got frightfully disfigured. A notable instance of this kind is afforded by the fables of Pilpay (Kalila and Dimna¹) from which La Fontaine borrowed the idea of several of his fables as he himself acknowledges: "I shall only say, from a sense of gratitude, that I owe the largest portion of them to Pilpay, the Indian sage." It has now been made out that Pilpay or Bidpai is a corrupt form of the Sanskrit word "विद्यापति" (master of learning).

Even long before the time of the Caliphs, India was the favourite resort of the students of medicine and other sciences. Thus Barzouhyeh, a contemporary of the celebrated

(1) ". . . . et malgré l'espèce de transformation que ce livre a dû subir en passant de l'indien en pehlvi, du pehlvi en arabe, de l'arabe en persan, on y retrouve encore des caractères frappans de cette origin"—de Sacy: "Calila et Dimna ou Fables de Bidpai, (1816), p. 5.

Sassanian king Nashirván, (A. D. 531-572), visited India to acquire proficiency in the Indian sciences.¹

Thomson, Hoefer, Kopp, and Berthelot have done ample justice to the claims of the Arabians as the originators or, at any rate, as the propagators of alchemy

Arabian indebtedness to India ignor-ed by the European historians of che-mistry.

in Europe in the middle ages. M. Berthelot, indeed, has recently shown that the ideas and theories, as regards alchemy, humoral pathology and physiology, which were promulgated in the writings of Geber, Rases, Avicenna, Bubacar and others, were essentially Greek in origin, though extended and improved upon by the Arabians. The French savant has, however, presented only one side of the

(1) ". . . . que Barzouyèh dans sa jeunesse, avoit déjà fait un premier voyage dans l' Inde, pour y rechercher des substances médicinales et de simples, et que c'était dans ce voyage qu'il avoit acquis la connoissance de la langue et de l'écriture Indiennes" *ibid*, p. 23.

shield.¹ In short, European historians of chemistry have scarcely one word to say on the indebtedness of the Arabians to the Hindus, who contributed not a little to the making of a Rases, a Serapion, or an Avicenna, who, in turn, were the chief inspirers of the European iatro-chemists down to the 17th century.²

Prof. Sachau, the learned translator and Prof. Sachau, however, does justice to editor of Albérûni's India, however, does justice to the claims of India.

(1) Cf. "—les Arabes, héritiers et traducteurs de la science grecque."—Berthelot : "La Chimie au moyen âge," I., préface, ii. "Les sciences naturelles furent surtout étudiées aux ix^e et x^e siècles, dans la célèbre école des médecins syriens de Bagdad, attirés et protégés par leurs clients. Dioscoride, Galien, Paul d'Egine furent ainsi traduits du grec en syriaque, puis en arabe ; parfois même traduits directement dans cette dernière langue," *ibid*, iv. "Les califes recherchaient les savants syriens, à cause de leur habileté médicale.....or toute leur science venait des Grecs" *ibid* II., Introduction, iii.

(2) Speaking of Albert the Great and Roger Bacon, Kopp writes : "beide haben aus derselben Quelle, den Arabern, geschnöpft." "Gesch. d. chem." I. 64. Draper equally ignores the contributions of the Hindus : e.g., "The teachers of the Saracens were the Nestorians and the Jews." "Hist. Intell. Dev. of Europe," Vol. I. p. 384, ed. 1896.

claims of both Greece and India in this respect, when he remarks :—

“The cradle of Arabic literature is not Damascus but Bagdad, the protection necessary for its growth being afforded by the Caliphs of the house of Abbas.

“The foundation of Arabic literature was laid between 750-850 A.D. The development of a large literature with numerous ramifications carried out with foreign materials, as in Rome the *origines* of the national literature mostly point to Greek sources. Greece, Persia and India were taxed to help the sterility of the Arab mind.”

We cannot conclude this chapter better than sum up its substance in the words of Prof. Sachau :—

“What India has contributed reached Bagdad by two different roads. Part has come directly in translations from the Sanskrit, part has travelled through Eran, having originally been translated from Sanskrit (Pāli? Prākrit?) into Persian, and farther from Persian into Arabic. In this way, e.g. the fables of Kālila and Dimna have been communicated to the Arabs, and a book on medicine, probably the famous Charaka cf. “Fihrist,” p. 303.

"In this communication between India and Bagdad we must not only distinguish between two different roads, but also between two different periods.

"As Sindh was under the actual rule of the Khalif Mansūr (A. D. 753-774), there came embassies from that part of India to Bagdad, and among them scholars, who brought along with them two books, the "Brahmasiddhānta" of Brahmagupta (Sindhind), and his "Khandakhādyaka" (Arkand). With the help of these pandits, Alfāzārī, perhaps also Yakub Ibn Tārik, translated them. Both works have been largely used, and have exercised a great influence. It was on this occasion that the Arabs first became acquainted with a scientific system of astronomy. They learned from Brahmagupta earlier than from Ptolemy.

"Another influx of Hindu learning took place under Harun, A. D. 786-808. The ministerial family Barmak, then at the zenith of their power had come with the ruling dynasty from Balkh, where an ancestor of theirs had been an official in the Buddhistic temple *Naubehār i. e. navavihāra*, the new temple (or monastery). The name Barmak is said to be of Indian descent, meaning *paramaka*, i. e. the superior (abbot of the *vihāra*?). Cf. Kern, "Geschichte des Buddhismus" in Indien, ii, 445,

543. Of course, the Barmak family had been converted, but their contemporaries never thought much of their profession of Islam, nor regarded it as genuine. Induced probably by family traditions, they sent scholars to India, there to study medicine and pharmacology. Besides, they engaged Hindu scholars to come to Bagdad, made them the chief physicians of their hospitals, and ordered them to translate from Sanskrit into Arabic, books on medicine, pharmacology, toxicology, philosophy, astrology and other subjects. Still in later centuries Muslim scholars sometimes travelled for the same purposes as the emissaries of the Barmak, e.g. Almuwaffak, not long before Albérūni's time ("Codex Vindobonensis, sive medici Abu Mansur liber fundamentorum pharmacologiæ, ed. Seligmann, Vienna, 1859, pp. 6, 10, and 15, 9.")

We shall finish with another appropriate extract from Prof. Macdonell's recent work¹ :—

"In Science, too, the debt of Europe to India
So also Prof. has been considerable. There is
Macdonell. in the first place, the great fact
that the Indians invented the numerical figures

(1) "Hist. Sans. Lit." p. 424.

used all over the world. The influence which the decimal system of reckoning dependent on those figures has had not only on mathematics, but on the progress of civilisation in general, can hardly be over-estimated. During the 8th and 9th centuries the Indians became the teachers in arithmetic and algebra of the Arabs, and through them of the nations of the West. Thus, though we call the latter science by an Arabic name, it is a gift we owe to India."

We have thus far attempted to present our readers with a brief, hurried and necessarily imperfect survey of the gradual evolution and development of Hindu medicine and alchemy from the Vedic age onward. We hope we have been justified in dividing this entire range into four distinct periods, each characterised by fairly well defined features. There are of course no sharp lines of demarcation—the one imperceptibly merging into the other. These are (1) The Ayurvedic Period ; (2) The Transitional period ; (3) The Tantric period ; (4) The Iatro-chemical period.

We shall now proceed to give a rough account of the chemical knowledge of each period—a more detailed description, especially of the Tantric period, being reserved for the second volume.

The Ayurvedic Period

(From the pre-Buddhistic Era to circa
800 A. D.)

CHAPTER I

The Constitution and Properties of Matter: the Atomic Theory

IT is not our purpose to discuss in the present volume the theories dominating Hindu medicine and, incidentally, chemistry. A concise preliminary summary of some of the salient features of the Sāṃkhya and Vaisesika systems of philosophy is, however, absolutely needed in order to follow with advantage the excerpts given in this book from the Charaka, the Susruta and other works. In connection with this, it would also be interesting to compare the indebtedness of Hippocrates to the doctrines of Parmenides, Empedocles and other philosophers of the same school.¹

(1) "Œuvres d' Hippocrate" by E. Littré, Paris, 1839, Tome 1. Intro. pp. 13 et seq. In connection with this chapter

Kanāda, the founder of the Vaisesika system, chiefly occupied himself with the study of the properties of matter. The atomic theory, as propounded by him, has many points in common with that of the Greek philosopher Democritus. His theory of the propagation of sound cannot fail to excite our wonder and admiration even at this distant date. No less remarkable is his statement that *light and heat are only different forms of the same essential substance*. But Kanāda is anticipated in many material points by Kapila, the reputed originator of the Sāmkhya philosophy. With the purely metaphysical aspects of these systems we are not concerned here. Their theories of matter and its constitution alone fall within the scope of our present enquiry. We shall now briefly refer to some of their doctrines.

The Sāmkhya, in common with other systems of Hindu philosophy, teaches that salvation in after-life is only attainable by perfect knowledge. According to Kapila, there are three sources of knowledge which consists in right discrimination of the perceptible and imperceptible principles

the reader may also consult Gomperz' "Griechische Denker", vol. I. ed. 1903, specially the articles : "Die Aerzte" pp. 221-254, and "Die Atomistischen Physiker", pp. 254-298.

of the material world from the immaterial soul. He enumerates these principles to be twenty-five in number. For our present purpose, however, a few of these only come within our purview. These we will present to our readers in the inimitable language of Colebrooke, whose masterly exposition of Hindu thought, though written nearly four scores of years ago, still retains its value and authoritative stamp¹ :—

TANMĀTRĀS OR PARTICLES.

“Five subtle particles, rudiments, or atoms, denominated Tanmātras ; perceptible to beings of a superior order, but unapprehended by the grosser senses of mankind : derived from the conscious principle, and themselves productive of the five grosser elements, earth, water, fire, air, and space.

FIVE ELEMENTS.

“Five elements, produced from the five elementary particles or rudiments. 1st. A diffused,

(1) Trans. Royal As. Soc., Vol. i pp. 19-43 and pp. 92-118
The European student who wishes to pursue the subject further may consult Max Müller's “Six Systems of Indian Philosophy” in which an ample and exhaustive bibliography will be found.

ethereal fluid (*ākāsa*), occupying space : it has the property of audibleness, being the vehicle of sound, derived from the sonorous rudiment or ethereal atom. 2nd. Air, which is endowed with the properties of audibleness and tangibility, being sensible to hearing and touch ; derived from the tangible rudiment or aerial atom. 3rd. Fire, which is invested with properties of audibleness, tangibility and colour ; sensible to hearing, touch and sight : derived from the colouring rudiment or igneous atom. 4th. Water, which possesses the properties of audibleness, tangibility, colour and savour ; being sensible to hearing, touch, sight and taste ; derived from the savoury rudiment or aqueous atom. 5th. Earth, which unites the properties of audibleness tangibility, colour, savour and odour ; being sensible to hearing touch, sight, taste and smell ; derived from the odorous rudiment or terrene atom.

ANIMATED ATOM.

"The notion of an animated atom seems to be a compromise between the refined dogma of an immaterial soul and the difficulty which a gross understanding finds in grasping the comprehension of individual existence, unattached to matter.

GROSSER BODY.

"The grosser body, with which a soul clad in its subtle person is invested for the purpose of fruition, is composed of the five elements, or of four, excluding the ethereal, according to some authorities ; or of one earth alone, according to others. That grosser body, propagated by generation, is perishable. The subtle person is more durable, transmigrating through successive bodies, which it assumes, as a mimic shifts his disguises to represent various characters."

We now come to the treatment of the subject by Kanāda in his famous Vaisēshika system. Here also we are indebted to Colebrooke for the following summary. Kanāda arranges the objects of sense in six categories, viz., substance, quality, action, community, difference and aggregation. According to him :—

"I. Substance is the intimate cause of an aggregate effect or product : it is the site of qualities and of action ; or that in which qualities abide, and in which action takes place.

"Nine are enumerated, and no more are recognised. Darkness has been alleged by some

philosophers ; but it is no substance ; nor is body a distinct one ; nor gold which the Mīmāṃsakas affirm to be a peculiar substance.

"Those specified by Kanāda are :

EARTH.

"1. Earth, which besides qualities common to most substances (as number, quantity, individuality, conjunction, disjunction, priority, posteriority, gravity, fluidity and faculty of velocity and of elasticity), has colour, savour, odour and feel or temperature. Its distinguishing quality is smell ; and it is succinctly defined as a substance odorous. In some instances, as in gems, the smell is latent : but it becomes manifest by calcination.

"It is eternal, as atomis ; or transient, as aggregates. In either, those characteristic qualities are transitory, and are maturative, as affected by light and heat : for by union with it, whether latent or manifest, form, colour, taste, smell and temperature are in earth of any sort annulled, and other colour etc. introduced.

"Aggregates or products are either organised bodies, or organs of perception, or unorganic masses.

'Organised earthly bodies are of five sorts. The organ of smell is terreous. Unorganic masses

are stones lumps of clay, etc. The union of integrant parts is hard, soft or cumulative as stones, flowers, cotton, etc.

WATER.

“2. Water, which has the qualities of earth ; excepting smell, and with the addition of viscosity. Odour, when observable in water is adscititious, arising from mixture of earthy particles.

“The distinguishing quality of water is coolness. It is accordingly defined as a substance cool to the feel.

“It it eternal, as atoms ; transient, as aggregates. The qualities of the first are constant likewise ; those of the latter inconstant.

“Organic aqueous bodies are beings abiding in the realm of Varuna. The organ of taste is aqueous : witness the saliva. Unorganic waters are rivers, seas, rain, snow, hail, etc.

“It is by some maintained, that hail is pure water rendered solid by the supervention of an unseen virtue : others imagine its solidity to be owing to mixture of earthly particles.

LIGHT.

“3. Light is coloured, and illumines other substances ; and to the feel is hot : which is its

distinguishing quality. It is defined as a substance hot to the feel. [Heat, then, and light are identified as one substance.]*

"It has the qualities of earth except smell, taste, and gravity. It is eternal, as atoms ; not so, as aggregates.

"Organic luminous bodies are beings abiding in the solar realm. The visual ray, which is the organ of sight, is lucid. Unorganic light is reckoned fourfold : earthy, celestial, alvine and mineral. Another distinction concerns sight and feel ; as light or heat may be either latent or manifest, in respect of both sight and feel, or differently in regard to either. Thus fire is both seen and felt ; the heat of hot water is felt but not seen ; moonshine is seen, but not felt ; the visual ray is neither seen nor felt. Terrestrial light is that, of which the fuel is earthy, as fire. Celestial is that of which the fuel is watery, as lightning and meteors of various sorts. Alvine is that of which the fuel is both earthy and watery : it is intestinal, which digests food and drink. Mineral is that which is found in pits, as gold. For some maintain that gold is solid light ; or, at least that

* The sentence under bracket is Colebrooke's own.

the chief ingredient is light which is rendered solid by mixture with some particles of earth. Were it mere earth, it might be calcined by fire strongly urged. Its light is not latent, but overpowered by the colour of the earthy particles mixed with it. In the *Mīmāṃsā*, however, it is reckoned as a distinct substance, as before observed.”¹

After giving an account of air and ether etc., Colebrooke proceeds with Kanāda’s

(1) The term “element” was not generally used in the modern sense of a component of a compound; rather it connoted certain properties characteristic of matter, e.g., coldness, dryness, heaviness, fluidity etc., thus it referred to certain qualities in the abstract. The Greek philosophers also held similar, if not identical, views. Cf. “Empedokles und die moderne Chemie.” pp. 185-86 of “Griechische Denker” by Gomperz vol. 1, ed. 1903. The following extract will also throw much light on the subject:

“The four so-called “elements”—air, water, earth and fire—were regarded by that intellectually great philosopher, Empedocles of Agrigent (about 440 B.C.), as the basis of the world; but neither he himself nor Aristotle, who adopted these into his system of natural philosophy, looked upon them as different properties carried about by one original matter. Their chief qualities (*the primæ qualitates* of the later scholastics) he held to be those apparent to the touch, viz., warm, cold, dry, and moist. Each of the four so-called elements is characterised by the possession of two of these properties, air being warm and moist,

CONCEPTION OF THE SIMPLE, BINARY, TERTIARY, AND QUATERNARY ATOMS.

" Material substances are by Kanāda considered to be primarily atoms ; and secondarily, aggregates. He maintains the eternity of atoms ; and their existence and aggregation are explained as follows :

" The mote, which is seen in a sunbeam, is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself ; and this likewise is a substance and an effect ; for the component part of a substance that has magnitude must be an effect. This again must be composed of what is smaller ; and that smaller thing is an atom. It is simple and uncomposed ; else the series would be endless : and, were it pursued indefinitely, there would be no difference of magnitude between a mustard seed

water moist and cold, earth cold and dry, and fire dry and warm. The differences in the material world were, therefore, to be ascribed to the properties inherent in matter.

* * * *

" Aristotle considered that his four elements were insufficient in themselves to explain the phenomena of 'nature ; he therefore assumed a fifth one, termed *ov'via*, which he imagined to possess

and a mountain, a gnat and an elephant, each alike containing an infinity of particles. The ultimate atom then is simple.

"The first compound consists of two atoms: for one does not enter into composition; and there is no argument to prove, that more than two must, for incohesion, be united. The next consists of three double atoms; for, if only two were conjoined, magnitude would hardly ensue since it must be produced either by size or a number of particles: it cannot be their size and, therefore, it must be their number. Nor is there any reason for assuming the union of four double atoms, since three suffice to originate magnitude. The atom then is reckoned to be the sixth part of a mote visible in a sunbeam.

"Two earthly atoms, concurring by an unseen peculiar virtue, the creative will of God, or time, or other competent, cause, constitute a double atom of earth; and, by concourse of three binary atoms, a tertiary atom is produced; and by

an ethereal or immaterial nature and to permeate the whole world. As the "*quinta essentia*" this played an immense rôle among the followers of the Aristotelian doctrine in the Middle Ages, and gave rise to endless confusion, from the endeavours of many (who, unlike Aristotle; supposed it to be material) to isolate it.

concourse of four triple atoms, a quaternary atom ; and so on, to a gross, grosser, or grossest mass of earth : thus great earth is produced ; and in like manner, great water from aqueous atoms ; great light, from luminous ; and great air, from ærial. The qualities that belong to the effect are those which appertained to the integrant part, or primary particle, as its material cause ; and conversely, the qualities which belong to the cause are found in the effect.

"The dissolution of substances proceeds inversely. In the integrant parts of an aggregate substance resulting from composition, as in the potsherds of an earthen jar action is induced by pressure attended with velocity, or by simple pressure. Disjunction ensues ; whereby the union, which was the cause of incohesion of members, is annulled ; and the integral substance consisting of those members, is resolved into its parts,

"There seems to be a high degree of probability in the assumption that Empedocles and Aristotle did not themselves deduce their theory of the elements, but derived it from other sources ; thus the oldest writings of India teach that the world consists of the four elements mentioned above, together with ether, which last is most likely related to Aristotle's *o'vvia*--Meyer's " Hist. of Chem". Eng. trans. ed. 1898. pp. 7-8.

and is destroyed : for it ceases to subsist as a whole.

**QUALITY OF THE SUBSTANCE VIZ.,
COLOUR, SAVOUR, ETC.**

‘II. Quality is closely united with substance ; not, however, as an intimate cause of it, nor consisting in motion ; but common : not a genus, yet appertaining to one. It is independent of conjunction and disjunction ; not the cause of them, not itself endued with qualities.

“Twenty-four are enumerated. Seventeen only are, indeed, specified in Kanāda’s aphorisms ; but the rest are understood.

“I. Colour. It is a peculiar quality to be apprehended only by sight ; and abides in three substances ; earth, water, and light. It is a characteristic quality of the last ; and, in that, is white and resplended. In water it is white, but without lustre. In the primary atoms of both it is perpetual ; in their products, not so. In earth it is variable ; and seven colours are distinguished : *viz.* white, yellow, green, red, black, tawny (or orange) and variegated. The varieties of these seven colours are many, unenumerated. The six simple colours occur in the atoms of the earth :

and the seven, including variegated, in its double atoms, and more complex forms. The colour of integrant parts is the cause of colour in the integral substance.

" 2 Savour. It is a peculiar quality, to be apprehended only by the organ of taste ; and abides in two substances, earth and water. It is a characteristic quality of the last ; and in it is sweet. It is perpetual in atoms of water ; not so in aqueous products. In earth it is variable, and six sorts are distinguished : sweet, bitter, pungent, astringent, acid, and saline.

"3. Odour. It is a peculiar quality, to be apprehended only by the organ of smell ; and abides in earth alone, being its distinguishing quality. In water, odour is adscititious, being induced by union with earthy particles ; as a clear crystal appears red by association with a hollyhock, or other flower of that hue. In air also it is adscititious : thus a breeze, which has blown over blossoms, musk, camphor, or other scented substances, wafts fragrant particles of the blossoms, etc. The flowers are not torn, nor the musk diminished ; because the parts are replaced by a reproductive unseen virtue. However, camphor and other volatile substances do waste.



GRAVITATION.

"12. Gravity is the peculiar cause of primary descent or falling.

"It affects earth and water. Gold is affected by this quality, by reason of earth contained in it.

"In the absence of a countervailing cause, as adhesion, velocity, or some act of volition, descent results from this quality. Thus a cocoanut is withheld from falling by adhesion of the foot-stalk ; but, this impediment ceasing on maturity of the fruit, it falls.

"According to Udayana Āchārya, gravity is imperceptible, but to be inferred from the act of falling. Vallabha maintains that it is perceived in the position of a thing descending to a lower situation.

LEVITY.

"Levity is not a distinct quality, but the negation of gravity.

FLUIDITY.

"13. Fluidity is the cause of original trickling.

"It affects earth, light and water. It is natural and essential in water ; adscititious in earth and

light ; being induced by exhibition of fire in molten substances, as lac, gold etc.

"Fluidity is perceptible by external senses, sight and touch.

"In hail and ice, fluidity essentially subsists, but is obstructed by an impediment arising from an unseen virtue which renders the water solid.

VISCIDITY.

14. "Viscosity is the quality of clamminess and cause of agglutination. It abides in water only. In oil, liquid butter, etc., it results from the watery part of those liquids.

SOUND.

15. Sound is a peculiar quality of the ethereal element, and is to be apprehended by the hearing. It abides in that element exclusively and is its characteristic quality. Two sorts are distinguished : articulate and musical.

THEORY OF THE PROPAGATION OF SOUND.

"To account for sound originating in one place being heard in another, it is observed, that sound is propagated by undulation, wave after wave,

radiating in every direction, from a centre, like the blossoms of a Nauclea. It is not the first, nor the intermediate wave, that is the sound heard: but the last that comes in contact with the organ of hearing: and therefore it is not quite correct to say, that a drum has been heard. Sound originates in conjunction, in disjunction, or in sound itself. The conjunction of cymbals, or that of a drum and stick, may serve to exemplify the first. It is the instrumental cause. The rustling of leaves is an instance of disjunction being the cause of sound. In some cases, sound becomes the cause of sound. In all, the conformity of wind or its calmness is a concomitant cause: for an adverse wind obstructs it. The material cause is in every case the ethereal fluid: and the conjunction of that with the sonorous subject is a concomitant cause."

It now only remains for us to furnish a précis of the atomic theory of Kanāda in the words of Max Müller:

ANUS OR ATOMS.

"What is thought to be peculiar to Kanāda, nay the distinguishing feature of his philosophy, is the theory of Anus or Atoms. They take the

place of the Tanmātrās in the Sāṃkhya philosophy. Though the idea of an atom is not unknown in the Nyāya-philosophy (Nyāya Sūtras, IV. 2, 4-25), it is nowhere so fully worked out as in the Vaisesika. Kanāda argued that there must be somewhere a smallest thing that excludes further analysis. Without this admission, we should have a *regressus ad infinitum*, a most objectionable process in the eyes of all Indian philosophers. A mountain, he says, would not be larger than a mustard seed. These smallest and invisible particles are held by Kanāda to be eternal in themselves, but non-eternal as aggregates. As aggregates again they may be organised organs, and inorganic. Thus the human body is earth organised, the power of smelling is the earthly organ, stones are inorganic.

"It is, no doubt, very tempting to ascribe a Greek origin to Kanāda's theory of atoms. But suppose that the atomic theory had really been borrowed from a Greek source, would it not be strange that Kanāda's atoms are supposed never to assume visible dimensions till there is a combination of three double atoms (Tryanuka), neither the simple nor the double atoms being supposed to be visible by themselves. I do not

remember anything like this in Epicurean authors, and it seems to me to give quite an independent character to Kanāda's view of the nature of an atom.

"We are told that water, in its atomic state, is eternal, as an aggregate transient. Beings in the realm of Varuna (god of the sea) are organised, taste is the watery organ, rivers are water inorganic."

"Light in its atomic state is eternal, as an aggregate transient. There are organic luminous bodies in the sun, sight or the visual ray is the luminous organ, burning fires are inorganic."

"Air, again, is both atomic and an aggregate. Beings of the air, spirits, etc., are organised air; touch in the skin is the aerial organ, wind is inorganic air. Here it would seem as if we had something not very unlike the doctrine of Empedocles.

* * * But though we may discover the same thought in the philosophies of Kanāda and Empedocles, the form which it takes in India is characteristically different from its Greek form."¹

(1) " Indian Philosophy ", pp. 584-85.

DATES OF THE PHILOSOPHICAL SŪTRAS—
THE QUESTION OF PRIORITY.

As regards the dates of the philosophical sūtras, nothing definite is known ; here, as in the subsequent portions of our history, we have to depend largely upon constructive chronology.

We quote below two short extracts from Professor Max Müller's "Indian Philosophy" which summarise all the information available at present on the subject :

"If we consider the state of philosophical thought in India such as it is represented to us in the Brāhmaṇas and Upanishads, and afterwards in the canonical books of the Buddhists, we cannot wonder that all attempts at fixing the dates of the six recognised systems of philosophy, nay even their mutual relationship, should hitherto have failed. It is true that Buddhism and Jainism were likewise but two philosophical systems out of many, and that it has been possible to fix their dates. But if in their case we know something about their dates and their historical development, this is chiefly due to the social and political importance which they acquired during the fifth, the

fourth, and the third centuries B. C., and not simply to their philosophical tenets. We know also that there were many teachers, contemporaries of Buddha, but they have left no traces in the literary history of India.

* * * * *

"We cannot be far wrong therefore if we assign the gradual formation of the six systems of philosophy to the period from Buddha (5th century) to Asoka (third century), though we have to admit, particularly in the cases of Vedānta, Sāmkhya and Yoga, a long previous development reaching back through Upanishads and Brāhmaṇas to the very hymns of the Rig Veda.

"It is equally difficult to fix the relative position of the great systems of philosophy, because, as I explained before, they quote each other mutually. With regard to the relation of Buddhism to the six orthodox systems it seems to me that all we can honestly say is that schools of philosophy handing down doctrines very similar to those of our six classical or orthodox systems are presupposed by the Buddhist Sūttas." (pp. 116 — 120)

As regards the question of priority, we shall also take the liberty to quote below from Prof.

Macdonell's "History of Sanskrit Literature":

"Turning to Philosophical Literature, we find that the early Greek and Indian Philosophers have many points in common. Some of the leading doctrines of the Eleatics, that God and the universe are one, that everything existing in multiplicity has no reality, that thinking and being are identical, are all to be found in the philosophy of the Upanishads and the Vedānta system, which is its outcome. Again, the doctrine of Empedocles, that nothing can arise which has not existed before, and that nothing existing can be annihilated, has its exact parallel in the characteristic doctrine of the Sāṃkhya system about the eternity and indestructibility of matter. According to Greek tradition, Thales, Empedocles, Anaxagoras, Democritus, and others undertook journeys to Oriental countries in order to study philosophy. Hence there is at least the historical possibility of the Greeks having been influenced by Indian thought through Persia.

"Whatever may be the truth in the cases just mentioned, the dependence of Pythagoras on Indian philosophy and science certainly seems to have a high degree of probability. Almost all the doctrines ascribed to him, religious, philoso-

phical, mathematical were known in India in the sixth century B. C. The coincidences are so numerous that their cumulative force becomes considerable. The transmigration theory, the assumption of five elements the Pythagorean theorem in geometry, the prohibition as to eating beans, the religio-philosophical character of the Pythagorean fraternity and the mystical speculations of the Pythagorean school, all have their close parallels in ancient India. The doctrine of metempsychosis in the case of Pythagoras appears without any connection or explanatory background and was regarded by the Greeks as of foreign origin. He could not have derived it from Egypt, as it was not known to the ancient Egyptians. In spite, however, of the later tradition, it seems impossible that Pythagoras should have made his way to India at so early a date, but he could quite well have met Indians in Persia."¹

(1) "History of Sanskrit Literature" pp. 421—22. Colebrooke himself sums up his views in these words :—"I should be disposed to conclude that the Indians were in this instance teachers than learners." "Trans. Roy. As. Soc.," Vol. 1., p. 579. Prof. H. H. Wilson observes :—"that the Hindus derived any of their philosophical ideas from the Greek seems very improbable, and if there is any borrowing in the case, the latter were most probably indebted to the former." Preface to the Sāṃkhya Kārikā (1837) p. ix.

CHAPTER II

Chemistry in the Charaka and the Susruta

THE CHARAKA

[The subject-matter in the first few extracts in this chapter is practically based upon the Vaisesika system ; see ante pp. 6 *et seq.*.]

THE TASTES—THE METALS AND THEIR CALCES

"The object of the tongue is taste. Water and earth are the objective existences in which taste inheres. In its manifestation and as regards particular kinds of it, space, air and light are also its adjuncts. Sweet, sour, salt, pungent, bitter and astringent, these are regarded as the sixfold catalogue of tastes. * * * Objects are again known to be of three kinds, *viz.*, animal products, vegetable products and products appertaining to the earth. Honey, vaccine, secretions, bile, fat, marrow, blood, flesh, excreta, urine, skin, semen, bones, tendons, horns, nails, hoofs, hair, bristles and

the bright pigment called *Gorochandā*,¹ are used (as drugs) among animal products. Gold, the five metals and their ordure [*i.e.* their calces, the five metals *viz.*, silver, copper lead, tin and iron], sand, lime, red arsenic, gems, salt, red chalk and antimony, are indicated as drugs appertaining to the earth.”²

A DISCOURSE ON THE TASTES—THEIR RELATIONSHIP TO THE FIVE PRIMAL ELEMENTS—THE NATURE OF THE ALKALI

“Once on a time, the son of Atri, and Bhadrakāpyas Śākuntēya and the full-eyed Maudgalya, and the golden-eyed Kausika, the sinless Bharadvāja otherwise called Kumārasiras, the blessed king Vāryovida, that foremost of all intelligent men Nimi, the ruler of the Videhas, Vadisa of high intelligence, and Kāmkhāyana-vālhīka, that foremost of all physicians of the Vālhika country,—these *Rishis*, all of whom were old in years and learning and all of whom had subjugated their souls, came together to the delightful Chaitraratha woods, desirous of passing a few days in enjoyment

(1) Concretions found in the gall bladder of the ox.

(2) A. C. Kaviratna's Translation of “Charaka Samhitā,” pp. 6-7.

and pleasure. As those *Rishis* conversant with every topic were seated there, the following discourse of grave import took place among them on the subject of the proper ascertainment of the (different) tastes and food.

"There is one kind of taste said Bhadrakāpya ; which persons skilled in the subject regard as are of the five subjects of the senses, *viz.*, that which relates to the tongue. That, again, is not different from water.

"The Brāhmaṇa Sākuntēya said there are two tastes, their virtues being that one of them cuts or removes from the body all bad humours or ingredients, and the other only checks or curbs them.

"There are three tastes, said the full-eyed Maudgalya. Their virtues are cutting, curbing, and both. .

"There are four tastes, said the golden-eyed Kausika. They are agreeable and beneficial, and agreeable and non-beneficial, disagreeable and beneficial.

"There are five tastes, said Kumārasira-Bharadvāja. They appertain to Earth, Water, Fire, Air and Ether (or Space).

"There are six tastes, said the royal sage

Vāryovida. They are heavy, light, cold, hot, oily and dry.

"There are seven tastes, said Nimi, the ruler of the Videhas. They are sweet, sour, saltish, pungent, bitter, astringent and alkaline.

"There are eight tastes, said Vađisa-Dhāmārgava. They are sweet, sour, saltish, pungent, bitter, astringent, alkaline and that which remains in an unmanifest form.

"The tastes are infinite in number, said Kām-khāyana, foremost among the physicians of the Vālhika country, in consequence of the infinite variety of their virtues, operations or effects and methods of corrections (or mixture for adding to their virtues, etc.,).

"The illustrious son of Atri, *viz.*, Punarvasu, said that the number of tastes is truly six. They are sweet, sour, saltish, pungent, bitter and astringent. The source from which these six flow, *i. e.* their origin, is water. Their operations or effects are of two kinds, *viz.*, cutting and curbing. In consequence, again, of mixture or combination, they become both cutting and curbing at the same time. Agreeable and disagreeable are their divisions that depend upon the likes and dislikes of men. Beneficial and non-beneficial are their

powers. The refuge of the tastes are the modifications of the five primal elements (of Earth, Water, Fire, Air and Ether or Space). The tastes, again, depend upon the (original) nature of their refuge, the modifications of that refuge, combinations of the substances that form their refuge, as also place, and time.¹

"The virtues or properties (attaching to the tastes) occur in those which constitute the refuge (of the tastes), called objects. Those virtues are heavy, light, cold, warm, oily, dry and others.

"*Kshāra* (alkali) is so called from its being produced by *ksharana* (dropping down or straining). This is not a taste. It is, on the other hand, an object. It is, in fact, produced from many kinds of taste. Hence, it has many tastes. Among them, pungent and saline predominate. It is composed of many objects of the senses. It is manufactured with the aid of different processes.

(1) The modifications of the five primal elements constitute the refuge of the tastes. Every substance is formed by modifications of those elements. What is said, therefore, is that material substances are the refuge of the tastes, i.e. the tastes inhere in them.

"At the outset, however, we shall say something referring to the diversity of objects (which are the refuse of the tastes). All objects are the results of the combinations of five primal elements (*viz.*, Earth, Water, Fire, Air and Ether or Space). As regards Medical Science, object are of two kinds, *viz.*, those endowed with animation and those that are inanimate. The attributes which inhere in objects are sound, &c., heaviness &c., ending with solubility."¹

We now quote only a few typical instances of mineral and metallic preparations.

THE FIVE KINDS OF SALTS

"The five kinds of salts *viz.*, sauvarchala, sindhava, vit, audbhida, with sāmudra." [See Index under the respective headings].

MINERALS FOR EXTERNAL APPLICATION

"Sulphate of copper, sulphate of iron, realgar, orpiment and sulphur in combination with vegetable drugs are prescribed for external application in ringworm, eczema, leprosy, &c.,"²

(1) Kaviratna's Trans., pp. 295-99.

(2) Sútra, Ch. III; 4-5.

THE EIGHT VARIETIES OF URINE

"The eight varieties of urine are those of the sheep, the goat, the cow, the buffalo, the elephant, the camel, the horse and the ass."¹

PREPARATION OF KSHĀRA (ALKALI)

"A young *butea frondosa* is to be cut to pieces and dried and finally reduced to ashes. The ash is to be lixiviated with four or six times its weight of water and strained (through linen) 21 times."²

PILL IRON COMPOUND

"Into the composition of pill iron compound pyrites and the rust of iron enter."³

A COLLYRIUM

"The ingredients of a collyrium are conch-shell, coral, lapis lazuli, iron, copper, the bone of the

(1) Ibid, Ch. I, 43.

(2) Chikitsā, Ch. XXIII, 26.

(3) Ibid, Ch., XVI 28.

frog, sulphide of antimony and the seed *hyper-anthera morunga*.⁽¹⁾

[The first five articles are interpreted as meaning the calces thereof.]

POWDER OF PEARL COMPOUND

"Among the constituents we have, pearl, sulphur, powder of iron, copper and silver."⁽²⁾

[The text does not precisely say whether the metals are to be used *as such* or *as killed* by being roasted with sulphur. The Hindu physicians however always take them in the latter sense.]

IRON, GOLD AND SILVER TONICS

"A thin iron plate is to be made red hot and plunged into the decoction of the myrobalans, cow's urine, the solution of 'the salts', the solution of the alkali extracted from the ash of *butea frondosa*; i.e. made red hot and plunged into one of the above liquids at a time. When the iron becomes black like collyrium it is to be powdered. * * *

(1) Ibid, Ch, XXVI, 123.

(2) Chikitsá, Ch. XVII, 40.

"The same process to be adopted in the case of gold and silver."¹

RASĀYANA DEFINED

"Medicines are of two kinds : the one promotes the strength and vitality of the healthy, the other cures diseases.

'Whatever promotes longevity, retentive memory, health, virility, &c. is called Rāsāyana.'²

THE SUSRUTA

PREPARATION AND USE OF ALKALIES AND ALKALINE CAUSTICS.³

"Of all cutting instruments and accessory cutting instruments, caustics are superior inasmuch as they perform the work of incisions, punctures and scarifications, relieve derangements of the three humours, *viz.*, air, bile and phlegm, and uniformly affect the diseased part to which they are applied. *Kshāra* (caustics) are so called

(1) Chikitsá Ch. I. 5, pp. 497-98.

(2) Ibid Ch. I. pp. 2-6.

(3) We have adopted Udoj Chand Dutta's Translation of Chs. XI and XIV with certain corrections here and there.

because they remove diseased parts and destroy the skin and flesh. From being composed of numerous medicines they can affect the three humours. Caustics being white in colour are cooling or of lunar origin.¹ This origin is not inconsistent with their burning, escharotic and lacerating properties. Being composed of numerous heating medicines, caustics are acrid, hot and pungent. They promote suppuration, destroy parts, improve unhealthy sores and promote granulation, dry up discharge, stop bleeding and abrade the skin. Their internal use removes worms, acidity, phlegm, skin diseases, some poisons and corpulence. Their excessive use causes impotence.

"Alkalies are of two sorts, namely, for external application and internal administration. They are used externally in the skin diseases called *kustha*, in keloid, ringworm leucoderma, lepra, fistula-in-ano, tumours, unhealthy ulcers, sinuses, condyloma, moles, chloasma, brown spots on the face, warts, external inflammations, worms, poisons and piles, and in the seven following diseases of the mouth

(1) The reader will not fail to notice that silver nitrate is, in the language of Western Alchemy, named *lunar caustic*.

namely, *upajihvā* (ranula), *adhijihvā* (tumour on the tongue), *upakusa* (inflammation of the gum), *dantavaidarbha* (inflammation of the gum from injury), and the three sorts of rohinī or inflammation of the throat. In these diseases of the mouth, accessory instruments, in the shape of caustics only, should be used. Alkaline solutions are administered internally in chronic or slow poisoning, abdominal tumours, ascites, loss of appetite, indigestion, disinclination for food, tympanitis, urinary deposits, calculi, internal or deep-seated inflammation, intestinal worms, poisoning and piles. Alkalies do not agree with children, old and weak people, and persons having a tendency to haemorrhage from internal organs, or a bilious temperament. They are injurious in fever, giddiness, intoxication, fainting, amaurosis and such other diseases.

"Alkalies for escharotic use are prepared like other alkalies by straining alkaline solutions as elsewhere explained in detail. They are made of three strengths, namely, weak, moderate and strong. He who wishes to prepare alkalies should in an auspicious day in autumn, fasting and in pure body, select a middle-aged, large-sized, uninjured *ghantapātali* tree with black flowers (*Schrebera swietenioides*) growing on an approved spot on a mountain, and

address it with certain *mantras* or incantations as a preliminary ceremony called *adhivāsa*. Next day the tree should be cut or killed after reciting the following *mantra* or prayer: "Oh you with great fiery power may not thy strength be lost ! Oh you auspicious tree, stay here and accomplish my work. After accomplishing my work you will go to heaven." Then the ceremony of *homa*, or burning the sacrificial fire, should be performed with one hundred red flowers. The tree should then be cut to pieces and piled in a place free from wind. Some limestone should be placed on the pile which should be set on fire by stalks of *Sesamum Indicum*. When the fire is extinguished, the ashes of the *ghantāpātali* tree and the burnt lime should be kept separate. In the same way the following trees may be burnt with their root, branches, leaves and fruits for the preparation of alkalies,¹ namely :

Kuṭaja	<i>Hollarrhena antidysenterica.</i>
Palāsa	<i>Butea frondosa.</i>
Asvakarna	<i>Shorea robusta.</i>
Pāribhadra	<i>Erythrina indica.</i>
Vibhitaka	<i>Terminalia bellarica.</i>

(1) Cf. *Rasārṇava*, below, where the standard "plant ashes" are enumerated.

Āragvadha	Cassia fistula.
Tilvaka	Symplocos racemosa.
Arka	Calotropis gigantea.
Snuhī	Euphorbia neriifolia.
Apāmārga	Achyranthes aspera.
Pātalā	Stereospermum suaveolens.
Naktamāla	Pongamia glabra.
Vṛīsha	Justicia adhatoda.
Kadalī	Musa sapientum.
Chitraka	Plumbago zeylanica.
Pūtika	Guilandina bonducella.
Indravriksha	Terminalia arjuna.
Āsphta	Salvadora persica.
Asvamāraka	Nerium odorum.
Saptachchhada	Alstonia scholaris.
Agni mantha	Premna serratifolia.
Gunjā	Abrus precatorius.
4 sorts of Kosā	4 varieties of Luffa amara."

LIXIVIATION OF THE ASHES

"Thirty two seers of ashes should be stirred or mixed with six times their quantity of water or cow's urine and the mixture strained through cloth. This should be repeated twenty-one times. The strained fluid should then be boiled slowly in a large pan and agitated with a ladle. When the fluid becomes clear,

pungent and soapy to the feel, it should be removed from the fire and strained through cloth. The filtrate¹ being thrown away, the strained fluid should be again boiled. From this alkaline solution take three quarters of a seer."

RENDERING THE ALKALI CAUSTIC

"Then take eight palas each of Banduc nut, burnt limestone, conch shells, and bivalve shells and heat them in an iron pan till they are of the colour of fire. Then moisten them in the same vessel with the above-mentioned three-quarters of a seer of alkaline water and reduce them to powder. This powder should be thrown on sixty-four seers of the alkaline water and boiled with constant and careful agitation by the ladle. Care should be taken that the solution is neither too thick nor thin."

HOW TO STORE UP THE ALKALI

"When reduced to proper consistence, the solution should be removed from the fire and poured into an iron jar. The opening or mouth of

(1) This is evidently a mistake. According to the original text, it should be "the dregs" i. e. the precipitate.

the jar should be covered, and should be kept in a secluded place. This preparation is called *madhyama kshāra* or alkaline caustic of middling strength. When the alkaline water is simply boiled to the proper consistence without the addition of burnt shells, &c., the preparation is called *mridu¹ kshāra* or weak alkaline solution. The strong alkaline caustic is prepared by boiling the weak solution with two tolahs each in fine powder of such of the under-mentioned ingredients as are available, namely :—

Dantī,	Baliospermum montanum.
Dravantī	Salvinia cucullata.
Chitraka	Plumbago zeylanica.
Lāngalikī	Gloriosa superba.
Pūtika	Guilandina bonducell.
Kanaka	Salvinia cucullata.
Kshīrī	Cleome felina.
Vachā	Acorus calamus.

“ Aconite root, carbonate of soda, asafoetida, black salt and corals.

“ This solution is used for bringing to a head or opening abscesses. These three varieties of alka-

(1) “Mridu” may be rendered more accurately as “mild.”

lies should be used according to the state of the disease. In weak persons, the alkaline water without the addition of other caustic ingredients, should be applied to strengthen the parts."

CHARACTERISTICS OF THE GOOD AND THE BAD ALKALI

On this subject there are the following verses :

"Good alkaline caustics should be neither too strong nor too weak. They should be white in colour, smooth and soapy to the touch, should not spread beyond where they are applied, and act rapidly and successfully. These are the eight good properties of caustics. Their bad qualities consist in their being too weak or cool, too strong or hot, too slippery and spreading, too thick or too under-boiled, or they may be deficient in ingredients.

"In applying caustic to a patient suffering from a disease curable by this remedy, he should be made to sit in a spacious place, protected from wind and sun. The physician should then procure the instruments or necessary articles according to the rules laid down in the fifth chapter. He should then examine the diseased part, rub, scarify or scratch it, and then apply the caustic by means of a probe, and

wait for the space of time required to utter one hundred words. The diseased part turns black on the application of the caustic which is a sign of its having been burnt. The application of some acid mixed with clarified butter or honey relieves the pain. If from the thickness of the burnt part. it does not fall off, the following application should be thoroughly applied to it, namely, equal parts of tamarind pulp, of the refuse of *kānjika* (fermented rice water i. e. crude vinegar), sesamum seeds and liquorice root rubbed together into a paste. Sesamum seeds and liquorice root rubbed together with clarified butter promotes granulation in ulcers."

WHY THE ACID NEUTRALISES THE ALKALI

"If you question, my son ! how is it that the application of the pungent acid of *kānjika* relieves the burning of the fire-like hot alkaline caustic, then hear the following explanation from me. Alkalies possess all the tastes except that of the acid. The acrid taste prevails in it and the saline one to a less degree (cf. *ante* p. 28). The sharp saline taste when mixed with acid becomes very mild, and gives up its sharp quality. From this modification of the saline taste, the pain of caustics is relieved just as fire is extinguished by water."

MILD AND CAUSTIC ALKALIES

It will be noticed that there is a distinct mention of "mild" and "caustic" alkalies in the body of the text. The process of lixiviating the ashes and rendering the lye caustic by the addition of lime leaves very little to improve upon, and appears almost scientific compared to the crude method to which M. Berthelot pays a high tribute :

"Fabrication de la Lessive :—Quatre muids de cendres sont répartis entre deux cuviers, percés de trous au fond. Autour du trou le plus petit, du côté intérieur, mets une petite quantité de foin, pour que la cendre n'obstrue pas le trou. Remplis d'eau le premier des cuviers ; recueille le liquide filtré qui en découle pendant toute la nuit et mets-le dans le second cuvier ; grade ce qui filtre de ce second cuvier. Mets d'autre cendre (dans un troisième cuvier). Epuise-la et il se forme une liqueur pareille au nard couleur d'or. Verse-la dans un quatrième cuvier. La liqueur devient piquante et forte : telle est la lessive particulière." "Coll. d. Alch. Grecs" III. trad. p. 357.

We reproduce the remarks of M. Berthelot on the above: "On a regardé comme modernes les procédés de lixiviation méthodique, usités pour

exprimer les cendres et les matériaux salpêtrés : le passage suivant, tiré du manuscrit de Saint-Marc, montre que ces procédés remontent au XIe siècle et sans doute au delà."—"Chimie des Anciens" p. 284.

DESCRIPTION OF BLOOD

(Chapter XIV of Sūtrasthānam)

"The four varieties of food derived from the five elements and having the six tastes, the two properties of heat and cold or according to some, eight properties and many qualities when taken in moderation and thoroughly digested, produces a fine substance imbued with energy and fire. This is called *rasa* (chyle). The heart is the seat of the *rasa* or chyle. From the heart it proceeds through 24 arteries, namely, ten ascending, ten descending, and four transverse to all parts of the body. By some unseen cause or destiny, this chyle continually satiates, increases, nourishes and supports the body and keeps it alive. The motion of this chyle throughout the body is inferred from the processes of decline, increase, and diseased condition of the different portions of the body. It may be asked whether this chyle which pervades all the external parts of the body, the three humours, the tissues,

including the blood and the receptacles of the secretions, is endowed with the property of heat or cold. As this chyle is a circulating fluid, and as it softens, vitalises, supports and nourishes the body, it should be known to possess the cooling property. This watery fluid no doubt assumes a red colour in the liver and spleen, that is, it is converted into blood in these organs. On this subject there is the following verse :

"The *rasa* (chyle) of living beings is coloured red by healthy bile. This coloured fluid is called blood. The blood excreted by women and called the menstrual fluid is derived also from this *rasa*. This menstruation, coming at the age of twelve, ceases at the age of fifty.

"The menstrual fluid is endowed with the property of heat, owing to the womb being possessed of both the properties of heat and cold. Other writers say that the blood of living beings is composed of the five elements. The five qualities of the five elements as seen in blood are as follows, namely, fleshy smell, liquidity, red colour, tendency to trickle or ooze, and lightness.¹ Blood is produced

(1) Cf. *ante* pp. 6-7 under Vaisesika Philosophy.

from chyle, flesh from blood, fat from flesh, bones from fat, marrow from bones, and lastly the semen is produced from marrow. The chyle produced from food and drink nourishes these constituent parts of the body. Living beings are produced from the *rasa*; hence sensible people should carefully preserve this *rasa* by conforming to the proper rules of diet and regimen.”¹

ON THE COLLECTION OF DRUGS (Chapter XXXVIII : Sūtrashānam)

37 classes of vegetable drugs are mentioned which chiefly constitute the Materia Medica. There is only one sloka in which the six metals *viz.*, tin, lead copper, silver, krishnaloha (iron) and gold, and their calces are recommended.

THE SALTS

Rock-salt, sea-salt, bit, sauvarchala, romaka and audbhid, &c. (see *ante* p. 29).

(1) The reader may compare the above theories on the Chemistry and Physiology of Digestion and Nutrition with those of Geber. *Vide “Traité d’Alchimie Arabe,”* trad. pp. 201-3.

THE ALKALIES

Yavakshāra (factitious carbonate of potash), sārjikākshāra¹ (trona or natron) ; the alkaline solution prepared according to directions given in Ch. XI ; and borax.

Internal administration of alkali is recommended for dissolving the stones or gravels (urinary calculi).

INTERNAL USE OF LEAD AND TIN

Lead and tin are described as vermifuge—a property also accepted by the later Iatro-chemists.

Powdered tin rubbed for seven days together with the creamy portion of curd is recommended for internal administration.

MINERALS FOR EXTERNAL APPLICATION

For the treatment of ulcer an external application of sulphate of copper, sulphate of iron, orpiment and realgar, &c., is prescribed.

(1) From the time of the Charaka and the Susruta, Hindu Pharmacy has always recognised these two alkalies as distinct.

Another recipe includes alum-earth, red-ochre, sulphate of copper, yellowish (basic) sulphate of iron, rock-salt, orpiment and realgar.¹

ROASTING OF IRON AND OTHER METALS, SO AS TO RENDER THEM FIT FOR INTERNAL

ADMINISTRATION.

Thin leaves of cast iron are to be smeared with the levigated powder of "the salt" and heated in the fire of the cow-dung cakes and then plunged into a decoction of the myrobalans and asafoetida. This process is to be repeated 16 times. The leaves are then to be ignited in the fire of the wood of *mimosa catechu* and afterwards finely powdered and passed through linen of fine texture.

The above process is equally applicable to the roasting of the other metals.²

THE ORIGIN OF BITUMEN

The origin of bitumen is much the same as in the Charaka and the Bower Ms.; the only difference

(1) Chikitsasthānam Ch. XIX, 37, ed. J. Vidyáságara.

(2) See Note on the "Metals and their Salts" p. 48

being that, according to Susruta, bitumen is related to six instead of four metals (see below p. 53).

IRON PYRITES

Iron Pyrites are collected on the bank of the river Tāpi, of the lustre of gold and silver respectively (see below under "Rasaratnasamuchchaya", Bk. II, 77-81 and prescribed in the treatments of diabetes, leprosy, &c.

GOLD DUST

Gold dust, mixed with lotus seed, honey, &c. is used as a tonic.

THE POISONS

The Poisons are classified as animal, vegetable and mineral respectively. Under the last we have *Phenasma bhasma*¹ and orpiment.

(1) It is sometimes taken to mean white arsenic; "but it is very doubtful if Susruta meant any native white arsenic by it. The derivation of the term implies that it was obtained by roasting some sort of stone or ore." Dutt.

USE OF MERCURY

The only references to mercury, which are however very vague, are तारः सुतारः सुसुरेन्द्रगापः सर्वश्च तुच्छः कुरुदिव्यं गागः ; and : रक्तं शूलं चन्दनं पारदस्तं काकोत्थादिः च्छारपिष्ठश्च वर्णः ।

NOTE ON THE METALS AND THEIR SALTS (चथुःस्ति) ¹

Six metals are recognised, namely : tin, iron, lead, copper, silver and gold.² The thin leaves of the metals by being plastered over with a paste of "the salts" (see p. 46) including common salt, salt-petre and sulphate of magnesia and afterwards subjected to roasting were no doubt converted into their respective oxides, chlorides or oxy-chlorides as the case may be. We have thus in

(1) अत ऊर्जमयस्त्रूतीर्यन्त्यामः । तौञ्ज्यलाहपवाणि तमूर्जन खवनवर्णे-प्रेदिमानि गोमयाप्तिप्रतमानि * * * सूच्छुर्णानि कारयेत् । Chikit., Ch. X, 9.

(2) वपूर्दिनानुसोङ्गानां वस्ताम् । Chikit., Ch. XIII, 3.

वपुषोसतावरजतक्ष्युषोऽसुवर्णानि । Sūtra., Ch., XXXVIII, 56.

the Susruta a crude and imperfect, but all the same *potentially modern*, process for the preparation of the metallic salts. The much reputed "potable gold" in the shape of the chloride of the metal was probably in this way obtained. It will be interesting to note the successive stages in the evolution of the chemical processes as we proceed. (See below especially under "Chemistry in Rasārnava," where the mixture of the salts is technically named "*vida*" and consists of green vitriol, alum, common salt, salt-petre, &c.).

The reader will find an analogy in the ancient Egyptian and Greek methods as preserved in the Leyden Parchment, one or two extracts from which cannot fail to be of interest. It may be added by way of explanation that mineral acids being unknown to the ancients they had often to take recourse to the roundabout way of heating metals in combination with a mixture of blue vitriol, copperas, common salt and so on (see under "Mineral Acids") in order to get their salts.

"Ayant pris quatre paillettes d'or, faites-en une lame, chauffez-la et trempez-la dans de la couperose broyée avec de l'eau et avec une autre (couperose) sèche, battez (une partie)...une autre avec la matière mélangée: déversez la rouille et jetez dans..."

"Il y a là deux recettes distinctes. Dans toutes deux figure le sulfate de cuivre plus ou moins ferrugineux, sous les noms de *chalconthion* ou couperose et de sory. La seconde recette semble un fragment mutilé d'une formule plus étendue: La première présente une grande ressemblance avec une formule donnée dans Pline pour préparer un remède avec l'or, en communiquant aux objets torréfiés avec lui une propriété spécifique active, désignée par Pline sous nom de *virus* *

* * ...ce qui complète le rapprochement entre la formule de Pline et celle du papyrus. Voici les paroles de Pline :

"On torréfie l'or dans un vase de terre, avex deux fois son poids de sel et trois fois son poids de misy; puis on répète l'opération avec 2 parties de sel et 1 partie de la pierre appelée schiste. De cette facon, il donne des propriétés activées aux substances chauffées avec lui, tout en demeurant pur et intact. Le résidu est une cendre que l'on conserve dans un vase de terre."

"Pline ajoute que l'on emploie ce résidu comme remède. L'efficacité de l'or, le plus parfait des corps, contre les maladies et contre les malfices est un vieux préjugé. De là, au moyen âge, l'idée de l'or potable. La préparation indiquée par Pline

devait contenir less métaux étrangers à l'or, sous forme de chlorures ou d'oxychlorures. Renfermait-elle aussi un sel d'or ? A la rigueur, il se pourrait que le chlorure de sodium, en présence des sels basiques de peroxyde de fer, ou même du bioxyde de cuivre, dégageât du chlore, susceptible d'attaquer l'or métallique ou allié, en formant du chlorure d'or, ou plutôt un chlorure double de ce métal. Mais la chose n'est pas démontrée. En tous cas, l'or se trouve affiné dans l'opération précédente.”¹

(1) “Coll. des Anciens Alch. Grecs,” Vol. I., pp. 14-15.

CHAPTER III

Chemistry in the Bower Ms.

THE ALKALIES

The alkalies in the Bower Ms. are the two carbonates of potash and soda. (Yavakshāra and Sarjikākshāra)

FUMES OF HORN

The fumes of horn are recommended as giving relief in hiccough. [Practically the same as "spirits of hartshorn."]

KSHĀRATAILA

"Oil, boiled with the ashes of long pepper, is a remedy for ear diseases" (Pt. ii. fasc. ii. p. 131). [Cf. The formula given in Chakrapāni (see p. 63)]

FORMULA FOR HAIR-DYE

Sulphates of copper and iron, boiled with the oil of belleric myrobalans * * * are used as a

remedy for turning grey hair into black (*ibid* ; p. 162).

RASAYANA DEFINED

It is called *Rasayana* because it has a beneficial effect on *Rasa* or chyle and other elements of the body. Cf. p. 32.

THE DOCTRINE OF BITUMEN¹

Bitumen is produced from the following four metals : Gold, copper, silver and iron. Gold and other metals in the mountains, when heated by the sun, emit their impurities, oil-like, heavy and clay-like : these are the bitumen.

A LINCTUS

With certain vegetable drugs and "riparian sulphide of antimony,"² a linctus is made up with honey into a paste. (Pt. ii. fasc. ii. p. 123)

(1) The whole of this chapter, in a practically identical recension, is found in the Charaka. See Bower Ms., Pt. II., fasc. ii., ch. xii., p. 167.

(2) Srotaja anjana ; it is one of the five kinds of anjana or substances used for collyriums. The word literally means produced from a river, especially from the Yamuna. See Garbe's "Indische Mineralien," p. 54.

FORMULÆ FOR EYE-OINTMENT

Red ochre, rasôt, galena, realgar, calx of brass
(रोतिकुसुम) in equal parts...

With pepper and calx (of brass) one should
boil gold on a slow fire together with clarified
butter.¹

(2) The Bower Ms., Pt. I., verses 110 and 111.

CHAPTER IV

Chemistry In the Vagbhata.

A typical example is contained in the following recipe :

Sulphate of copper, red ochre, realgar, orpiment sulphate of iron, &c., are recommended for external application for genital sores.

PREPARATIONS OF GOLD, SILVER, COPPER, IRON AND LEAD

Gold, copper, silver, iron or tin are to be taken with the myrobalans, rock-salt and honey, &c.

Gold, silver, copper and iron are to be taken in conjunction with bitumen and milk.

Take 64 parts of stibium¹ and one part each of

(1) “ “स्रोतांशुन” ” Srotanjana is evidently stibnite or the native sulphide of antimony (See p. 53); Dutt translates it, we know not on what grounds, as calx-spar.

copper, iron, silver and gold ; now roast them in a closed crucible, &c.¹

Take 30 parts of lead, 5 parts of sulphur, 2 parts of copper and orpiment each, 1 part of tin and 3 parts of stibium. Now roast them in a closed crucible.²

[Here as well as in the preceding sloka, we have distinct mention of असूषा or a *crucible with the lid on*. This is one of the preparations which can be brought into line with those of the Tāntric and Iatro-chemical periods.]

PREPARATION OF ALKALI AND CAUSTIC ALKALI³

[As Vāgbhata borrows his method of preparation of alkali almost word for word from Susruta, it is quite superfluous to reproduce it here.]

(1) Uttarasthānam, Ch. XIII, p. 20-21.

(2) Ibid, Ch. XIII, p. 31-32.

(3) Sútra., Ch. XXX.

USE OF MERCURY

Take equal parts of mercury and lead and make them up into a collyrium with their equal weight of stibium and camphor.¹ [This is perhaps the only instance in which the mention of mercury is found.]

(1) "Uttarasthānam," Ch. xiii, 36. This very formula, with but slight variations, occurs also in Rasaratnasamuchchaya, Ch. xxiii, 46.

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The Transitional Period

(From 800 A.D. to circa 1100 A.D.)

**Chemistry in the Siddha Yoga of Vrinda
and in Chakrapani**

CHAPTER I

VRINDA

(*Circa 900 A. D.*)

PREPARATIONS IN WHICH SULPHIDE OF COPPER

AND

AETHIOPS MINERAL FIGURE

Sulphur, copper and the pyrites are to be pounded together with mercury and subjected to roasting in a closed crucible and the product thus obtained to be administered with honey. This is known as "parpati tāmram.¹"

(1) This preparation does not occur in the Poona edition, but is to be found in the Kásmír Ms. under रसायनाधिकारः.

Take one part of sulphur and half its weight of mercury [The components to be rubbed together.] The same to be administered with honey and clarified butter. This is called “*rasāmrīta chūrnām*.¹”

Quicksilver, rubbed with the juice of *dhatura* s. or *piper betle*, and applied externally, kills lice. (Poona ed. p. 122.)

A COLLYRIUM

Compounded of 14 ingredients amongst which occur the belleric myrobalans, rock-salt, killed copper and blue vitriol—all in the powdered form. (Poona edition, p. 470.)

This very preparation, in identical recension, occurs in Chakrapānī under the name of “*Nāg-ārjuna Varti*.”

A PROCESS OF KILLING IRON

The, text which occurs only in the Kāsmīr Ms. under रमायनाधिकारः unfortunately in a mutilated form, would seem to indicate that the iron is

(1) *Vide* Kāsmīr Ms. under अस्तपित्ताधिकारः, omitted in the Poona edition.

to be first ignited in the fire and then macerated in the juice of the emblic myrobalan, and *trewia nudiflora* and exposed to the sun, and again to be macerated in the juice of certain other plants and then to be rubbed in a mortar.

CHAPTER II

CHAKRAPANI

(*Circa 1060 A. D.*)

BLACK SULPHIDE OF MERCURY (KAJJALI)

or

Æthiops Mineral

The first process consists in the purification of mercury.

“Quicksilver, rubbed repeatedly in the juice expressed from *sesbania aculeata*, *ricinus communis*, *zingiber* and *solanum nigrum*, becomes purified.”

“Take one part of mercury and one part of sulphur, rub the two together in a mortar and thus prepare *kajjali* or *rasaparpati*.¹”

(1) Chakrapāni himself claims its discovery or at any rate its introduction : रसपर्पटिका स्थाता निवद्धा चक्रपाणिना । Vrinda, however, recommends its use as well.

**TAMRAYOGA (LIT. POWDER OF COPPER
COMPOUND)**

“Take a thin leaf of Nepalese copper and embed it in powdered sulphur. The substances are to be placed inside a saucer-shaped earthen-ware vessel and covered with another. The rims are luted with sugar or powdered rice-paste. The apparatus is heated in a sand-bath for three hours. The copper thus prepared is pounded and administered with other drugs.”

PROCESS OF KILLING IRON

“I shall now describe the science of iron as promulgated by the sage Nāgārjuna.” [A tedious process given with wearisome minutiae of which the substance only is reproduced below.]

A bar of iron is to be rubbed with the levigated powder of the following vegetable products among others : the belleric myrobalans, *clitoria ternatea*, *vitis quadrangularis*, *boharhaavia diffusa* and *verbesina calend.* It is then strongly heated to the fusion point and plunged into the decoction of the myrobalans. The iron is then powdered by being beaten with an iron hammer. The powder

is then digested in the decoction of the myrobalans and roasted repeatedly in a crucible.

MANDŪRA OR RUST OF IRON.

Rust of iron is prescribed in combination with other drugs.

RECIPE FOR A SOAP TO BE USED AS A DEPILATORY.

The ashes of *schrebera swiet.* and *cassia fist.* are to be mixed with lime from burnt shells and lixiviated with the urine of the ass. The lye is then to be boiled with a definite weight of mustard oil.

PREPARATION OF CAUSTIC ALKALI

[Much the same as in the Susruta]

CALX OF SILVER

In a preparation named “yogarāja” योगराज or calx of silver (probably in the shape of sulphide) figures as a component.

The Tantric Period

(From 1000 A.D. to circa 1300 A.D.)

CHAPTER I

Chemistry In Rasarnava

[In Rasārnava, as in all other Tantras, knowledge is imparted in the shape of a dialogue between Bhairava (Siva) and his consort Pārvatī.]

EXTRACTS FROM Book IV—ON APPARATUS AND THE COLOUR OF FLAMES

Sri Bhairava said :

“The rasas, the uparasas (see p. 79), the metals, a piece of cloth, *vidam* (see p. 72), a pair of bellows, iron implements, stone pestles and mortars, the apparatus known as *Koshtī* (see p. 69), mouth blow pipe * * cow-dung, substantial wood (as fuel), various kinds of earthen apparatus (*e.g.* crucibles &c.), a pair of tongs and earthen and iron vessels, weights and balances, bamboo and iron

pipes, the fats, the acids, the salts and the alkalies, the poisons—all those are to be collected and chemical operations begun."

DOLA YANTRAM

As R. R. S.¹ borrows the description of this apparatus *verbatim*, it is unnecessary to repeat it here.²

AN APPARATUS FOR KILLING METALS

"Make two iron crucibles each 12 digits in length, the one with a narrow orifice containing sulphur is inserted into the other holding mercury ; below the mercury is placed water [in a separate vessel]. The mercury and the sulphur should be carefully moistened in garlic juice, which has been filtered through a cloth. The apparatus is now lodged in an earthen pot and another placed over it, the rims being luted with cloth previously smeared with earth * * now cow-dung fire is urged. After continuing heating for three days

(1) R. R. S. is the abbreviation for 'Rasaratnasamuchchaya.'

(2) See Book ix. of R. R. S.

the apparatus is taken out." [This description, in almost identical recension, occurs in R. R. S. under the name of जारणाशक्तम्. The language is faulty and the meaning not very clear.]

GARBHA YANTRAM

"I shall now describe the Garbha Yantram for reducing *pistikā*¹ to ashes. Make a crucible 4 digits in length, and 3 digits in width, with its mouth rounded. Take 20 parts of salt and one of bdellium and pound them finely, adding water frequently; rub the crucible with this mixture.

* * * Make a fire of paddy husks and apply gentle heat. In the course of one to three days the mercury is reduced to ashes." [Vide Illustrations.]

EFFICACY OF THE APPARATUS

"For killing and colouring mercury, an apparatus is indeed a power. Without the use of

(1) A cake of mercury and sulphur.

herbs and drugs, mercury can be killed with the aid of an apparatus alone; hence an expert must not disparage the efficacy of the apparatus."

HAMSAPĀKA YANTRAM

"Take an earthen dish and fill it with sand and place another over it; apply gentle heat. Now digest in this apparatus [the ingredients] with the five alkalies (cf. pp. 45 and 69), the urines (see p. 30), and the "vida" (see p. 72). This is known as *Hamsapāka Yantram* by the adepts."¹

CRUCIBLES

"Earth of black red, yellow and white colour
 * * burnt husks of paddy, soot, earth from
 the ant-hill, well burnt excrements of the goat and
 the horse * * rust of iron" * *
 [varying proportions of the above ingredients are
 used for making crucibles, retorts, &c.]

"There are two kinds of crucibles, *viz.*, open
 and covered (lit. blind) * * * the covered one

(1) R. R. S. has borrowed the descriptions of *Garbha Yantram* and *Hamsapāka Yantram*.

resembles the nipple of a cow and is fitted with a lid, which has a raised head.

"For the purification of silver, the crucible is best made of two parts of the ashes of *schrebera swietenoides*, and one part each of brick dust and earth."¹

COLOUR OF FLAMES

"Copper yields a blue flamethat of the tin is pigeon-coloured ; that of the lead is pale-tinted².....that of the iron is tawny ; .that of the "peacock" ore (sasyaka) is red."³

TEST OF A PURE METAL

"A pure metal is that which, when melted in a crucible, does not give off sparks nor bubbles, nor spouts, nor emits any sound, nor shows any lines on the surface, but is tranquil like a gem.⁴

(1) The porous crucible is of the nature of a "cupel".

(2) Cf. "Lead compounds impart a pale tint to the non-luminous gas flame." (Roscoe and Schorlemmer.)

(3) The reading in the MSS. seems to be defective.

(4) Or in modern phraseology shows 'signs of tranquil fusion.'

KOSHTI APPARATUS

"For extracting the essence of metals a koshṭī apparatus [*Vide Illustrations*] is preferred, which is 16 digits in width and 2 cubits in length."

COLOPHON TO CHAPTER IV.

"Here ends Chapter fourth of *Rasārnava*, which treats of apparatus, crucibles and the colour of flames."

THE ALKALIES

"The three alkalies are the borax, trona (natron) and Yavakshāra (carbonate of potash). The ashes of sesamum, *achyranthes aspera*, *musa sapientum*, *butea frondosa*, *moringa pterygosperma*, *mochika*, (*schrebera swietenioides*), *raphanus sativus*, *zingiber officinale*, *tamarindus indicus* and *ficus relig.*, respectively are regarded as the standard plant ashes (वस्त्राराणः)। VII. 12-13

THE MAHARASAS

"Bhairava said :—“mākshika, vimala, silā, chāpala, rasaka, sasyakā, darada (p. 78) and sroton-

jana,—these are the eight mahārasas." [Vide p. 79 and "Explanatory Notes on Minerals."] VII. 2-3

COPPER FROM THE PYRITIES.

" Mākshika, repeatedly soaked in honey, oil of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum*, and heated in a crucible, yields an essence in the shape of copper." VII. 12-13

" Vimala, digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musa s.*, and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet*, yields an essence in the shape of *chandrārka*^x (lit. copper of gold-like lustre.)"

Chapala : [See under R. R. S. Bk. ii.] VII. 20-21

BRASS FROM CALAMINE AND COPPER MISTAKEN FOR GOLD.

" Rasaka : There are three, kinds of it; namely of yellow colour, of the appearance of treacle, and

(1) R. R. S. has borrowed this description and added some more characteristics of the mineral, from which it would appear that " Vimala " is also a variety of pyrites. [Vide R. R. S. Bk. II.]

of the colour of stones. What wonder is it that Rasaka mixed with [certain organic matters] and roasted three times with copper converts the latter into gold?"

VII. 31-34

EXTRACTION OF ZINC FROM CALAMINE.

Rasaka, mixed with wool, lac, *T. chebula* and borax and roasted in a covered crucible, yields an essence of the appearance of tin: of this there is no doubt."

VII. 37-38

Sasyaka.

VII. 41-44

[These couplets have been borrowed word for word by R. R. S. *Vide* Bk. ii; hence repetition is unnecessary.]

SAURĀSHTRI.

Saurāshtri, alum, distillation of: (See under R. R. S., which has also borrowed this description *verbatim*.)

VII. 73-74

THE METALS.

"O goddess! listen now to what I say about the metals.

'Gold, silver, copper, iron, tin and lead' these are the six metals and their resistance to waste [*i. e.* rusting] is in the order in which they have been mentioned." VII. 89-90

THE KILLING OF METALS—"VIDA."

"Hear attentively as I shall now speak of the killing of metals.

"There is no such elephant of a metal which cannot be killed by the lion of a sulphur." VII. 138-148

Bhairava said : "Kāsisa¹, rock-salt, the pyrites, sauvira², the aggregate of the three spices³, sulphur, saltpetre, the juice expressed from mālati⁴—all these moistened with the juice of the root of *moringa pter.*, makes a *vida*, which would kill all [the metals]."

IX. 2-3

"Sulphur, orpiment, sea-salt, salt, sal-ammoniac, borax—these digested with the ashes and the urines, give rise to another kind of *vida*." * * *

* * * Having thus collected the ingredients, O goddess ! begin the chemical operations. I have told you all what more do you want to hear ?"

IX. 4-20

(1) Green vitriol. (2) Stibnite. (3) namely, black pepper, long pepper and dry ginger. (4) *Echites caryophyllata*, Rox.

PURIFICATION OF QUICKSILVER.

"Quicksilver rubbed with the juice of the aforesaid plants (*vide* original text) and distilled seven times, becomes pure."

"Quicksilver, made into a paste by being rubbed with copper and subjected to distillation, leaves behind tin and lead [with which they are often adulterated] and becomes pure." X. 55-56

KILLING OF MERCURY.

"Green-vitriol, alum, salt, borax, mixed with the aforesaid vegetable drugs, (*vide* original text), kill mercury in an instant [in the shape of calomel.]" XI. 24

KILLING OF GOLD

"Salt-petre, green vitriol, sea-salt, rock-salt mustard, borax, salammoniac, camphor, the pyrites—all these are to be taken in equal parts. The crucible is to be smeared with the milky juice of *euphorbia neriifolia* and *asclepias gigantea*; then, having added the powder of the aforesaid "vida," the gold is to be killed, my beloved!"

XI. 83-84

TESTS FOR KILLED MERCURY

"When the mercury assumes divers colours after having given up its fluidity, it is known as swooned; killed mercury is that which does not show signs of fluidity, mobility and lustre."

XI. 197-198

COLOURING OF METALS

"Iron, lead, and copper are coloured by means of calamine—the whole turns into gold." (Cf. VII. 31-34.)

XII. 50

"Mercury is composed of the five elements and represents Siva himself."

II. 78

"Take one pala of the ash of mercury and rub it with the same weight of sulphur and roast the mixture in a covered crucible: thus we get vermillion of the colour of the rising sun."

XVI. 81

"Take the vitriol which is of the colour of the throat of the peacock, saffron, calamine, as also the excrement of a young calf, the poisons, powdered *plumbago seyanica*, all in equal proportions, rub them with the acids and dry in the shade. Having added honey to the above mixture,

smear it on a thin sheet of lead. When roasted in a covered crucible, the lead is coloured in no time ; the lead which is now of beautiful colour is fit for bedecking the persons of the gods.”¹ XVIII. 70-74

(1) Refers probably to the “gold-like alloy used by watch-makers” into the composition of which copper, zinc and lead enter. See Roscoe and Schor., II. p. 494, ed. 1897.

The Iatro-Chemical Period

(From 1300 A. D. to circa 1550 A. D.)

CHAPTER I

Chemistry In Rasaratnasamuchchaya

BOOK I

Salutation to him—the excellent, the greatest physician of the world, by the nectareous ocean, of whose benign glance, resplendent with brilliance, born of everything that is joyous and auspicious and which acts like unfailing elixir, the diseases of his devotees, such as birth, death, old age and worldly attachment, are cured in an instant.¹ I

(1) The salutation is strictly Buddhistic and is on all fours with the opening lines of Vágbhata's Ashtángarhridaya and of Amarakośha, both of which are known to be by Buddhist authors; cf. also Lalitavistara :

बैद्यः सर्वस्य लोकस्य वन्देऽहमपि त्वां विभी । VII. p. 123, R. L. Mitra's ed

भारात्राधिकिलिष्टानां प्रादुर्भृतो किषग्वरः । xii, p. 150.

Ādima,¹ Chandrasena, Lankesa, Bisārada, Kapāli, Matta, Māndavya, Bhāskara, Sūrasenaka, Ratnakosa, Sambhu, Sāttvika, Naravāhana, Indrada. Gomukha, Kambali, Vyādi, Nāgārjuna, Surānanda, Nāgabodhi, Yasodhana, Khanda, Kāpālika, Brahmā, Govinda, Lampaka and Hari—these are the twenty seven experts on Alchemy as also Rasāmkusa, Bhairava, Nandī, Svachchhanda-bhairava, Manthānabhairava, Kākachandīsvara, Vāsudeva, Rishyasringa, the compiler of alchemy, the ascetic Rasendratilaka, Bhāluki, who has got the appellation of Maithili, Mahādeva, Narendra, Ratnākara and Harisvara.

2-7

This treatise on well-tried mercurials and minerals, named “Rasaratnasamuchchaya,” adapted to the treatment of diseases, is being compiled by the son of Simhagupta, after having consulted the works of the aforesaid adepts and others. It will treat of mercury, the minerals and the metals, the construction of the apparatus, the mystical formulæ for the purification of the metals, the extraction of the essences (active principles), liquefaction and incineration.

8-10

[Here follows a description of the virtues of mercury and its mythical origin.]

(1) The Benares Ms. reads Agama.

By partaking of mercury, men are freed from a multitude of diseases, arising out of the sins of former existence—of this there is no doubt. 26

He who falls foul of mercury, which is the generative principle of *Siva*, will rot in the hell *æon* after *æon*. 29

From the mouth of the God of fire * * mercury dropped into the country of Darada¹ and it has there remained ever so long. The soil of that region, on being subjected to distillation, yields mercury. 89-90

COLOPHON

Here ends Book first of *Rasaratnasamuchchaya*, composed by Vāgbhata, son of Simhagupta, Prince of Physicians.

(1) Dardistan, the mountainous region about Kásmír, is famous for the ores of cinnabar from which mercury is extracted. Darada is in fact a name of cinnabar. The auriferous region of the Daradas is mentioned by Humboldt (*Kosmos* 11. p. 513 E. C. Otte) who places it either in the Thibetan highlands east of the Bolor chain, west of Iskardo, or towards the desert of Gobi described also as auriferous by Hiouen Thsang. Regarding Párada and Darada see also Lassen's *Alterthumskunde*, 1. pp. 848-49. It seems probable that "párada" (quicksilver) and "darada" (cinnabar) owe their names to the countries from which their supply was obtained.

BOOK II

THE RASAS.

In the Hindu *Materia Medica* the mineral kingdom is broadly divided into the Rasas and the Uparasas, the Ratnas (gems) and the Lohas (metals). The term *Rasa* is in general reserved for mercury, though it is equally applicable to a mineral or a metallic salt. In the oldest medical works, *e. g.* the *Charaka* and the *Susruta*, *Rasa* has the literal meaning of juice or fluid of the body, which according to the notions of humoral pathology engenders blood, serum, sweat, &c., (see p. 42). *Rasakriyā*¹ in the *Susruta* means fluid extract or concentrated decoction. As mercurial and metallic preparations gradually came into vogue and even began to supplant the vegetable drugs, the term *rasa* began to be substituted for quicksilver on account of its semi-fluid character and its supposed miraculous therapeutical action on the juices or humours of the body (Cf. *Rig-Veda*, "Somarasa": *Vide* Intro.) In the *Bāvaprakāśa* we

(1) साखसारादिसारेत्वं पटोलविफलासु च

रसक्रिया विधातव्या शीधनो शीधनेत्वं च। Sútra. Chap.
xxxvi, 19.

find rasa used in a two-fold sense,—ancient and comparatively modern.¹

In the older works Rasāyana (derived from *rasa*, juice, and *ayana*, way) means a medicine preventing old age and prolonging life—the *Elixir vitae*.² Later on Rasāyana was almost exclusively applied to the employment of mercury and other metals in medicine and at present it means also alchemy (chemistry). Our author uses the term

(1) सत्यक् पक्षस्य भक्षस्य सारो निगदितारमः ।

स तु द्रवः सितः शीतः स्वादुः सिंधयलाभवेत् ॥ Vol. I, p. 59. ed. Kálisa Chandra Sen Gupta.

In the above sloka, rasa is used in the sense of *chyle*. Again :—
रसायनाधिभिर्लिङ्कैः पारदो रस्यने दतः ।

तता रस इति प्राकः स च धातुरपि च्युतः ॥ ibid. p. 442.

Here "rasa" is used as a synonym of mercury and regarded as a metal.

(3) For the definition of the term Rasāyana in the Charaka, see p. 32; cf. also "रसायनच्च तज्ज्ञात् यज्जरान्वाधिर्विजात्मम्" Sāngadharā. Cf. also : "Dies Wort (*rasa*) nämlich hat nicht nur der *rasagnána*, d. i. Kenntniss der Säfte, einem Kapitel der Medicin, sondern einer Benennung der Alchemie, *rasasástra*, dann *rasasiddhi*, durch Quecksilber erlangte Vollkommenheit, das Vertrautsein mit der Alchemie, sowie desgl. *rasendradarsana* (wortl. Untersuchung des Säfte-Herrschers d. i. Quecksilbers), Lehre der Alchemisten (dieser heisst *Rasāyana*) seinen Namen geliehen und ausserdem in Compositen einer Menge chemischer Substanzen."—Pott : "Chemie oder Chymie?" "Zeit. deut. Morg. Ges." xxx. 7

"Rasasiddhipradāyakā" (1-5), which is derived from rasa, mercury, siddhi, accomplishment and pradāyaka, giver or bestower, *i.e.* lit. giver of accomplishment in mercury *i.e.* an expert on alchemy. Wilson in his Dictionary thus happily renders Rasasiddhi: "The knowledge of alchemy, the possession of peculiar familiarity with mercury obtained by the performance of chemical operations conjoined with certain mystical and magical rites and the securing thence to the adept of happiness, health and wealth; the power of transmuting metals and the art of prolonging life."

With these prefatory remarks, we shall now allow our author to proceed.]

Abhra (mica), Vaikrānta, Mākshika (pyrites), Vimala, Adrija (bitumen), Sasyaka, Chapala, and Rasaka: these 8 rasas are to be identified and collected. ¹ [Vide "Explanatory Notes on the Minerals" at the end of Chap. I]¹

ABHRA

There are three varieties of mica, namely,

(1) Rasárnava (p. 69) recognises the following eight minerals:—mākshika, vimala, adrija, chapala, rasaka, darada (cinnabar) and srotonjana (stibium).

pinākam, nāgamandūkam and *vajram* and each of these again are of four different colours—white, red, yellow and black. 5-10

Mica, the layers of which can be easily detached, is preferred. Mica, which is as bright as the moon and which has the lustre of the rust of iron, does not take up or combine with (lit. swallow) mercury. That which has taken up mercury can alone be used with the metals and administered in medicine. Mica, which has been *killed*, is prescribed in the treatment of various diseases. The variety which has the lustre of the moon, if taken internally, brings on dyspepsia and urinary disorders. 12-14

Mica, heated seven times and plunged into sour gruel or cow's urine or decoction of the chebulic myrobalans or cow's milk, is freed from all impurities. 17-18

Mica, mixed with paddy grains and reduced to powder, tied in a piece of cloth and suspended in sour gruel and then passed through linen, is known as *Dhānyabhrām* (lit. mica in combination with paddy). *Dhānyabhrām*, rubbed with the juice of *cassia sophora* and roasted ten times in a closed crucible, is *killed* thereby. 24

VAIKRANTA

Vaikrānta has eight faces and six angles, is slippery and heavy and of uniform or mixed tint. It has 8 different colours, *viz.*, white, red, yellow blue, with the shades met with in the down of the pigeon, grass-green, black and variegated 55-56

Vaikrānta is a powerful tonic and reckoned among the sovereign medicines. It is a destroyer of all (bodily) disorders and is employed in the place of diamond. 57-58

Vaikrānta is purified by being heated three days with the salts and the alkalies or by digestion with the acids, urines or a decoction of *dolichos uniflorus* and the plantain or of *paspalum scrobiculatum*. It is killed by being roasted in a covered crucible eight times in combination with sulphur and lemon juice and *pasp. scrobi.* 67-68

Vaikrānta, after being heated and plunged into the urine of the horse, ought to be repeatedly roasted and then reduced to ashes. 69

Vaikrānta after incineration is substituted for diamond. 70

Macerated in the ashes of *schrebera swiet. butea frondosa* and cow's urine and mixed with the powdered root of *euphorb. antiqu.*, turmeric . . .

borax, powdered lac and made into balls with the milky juice of *asclepias gem.*, and honey and strongly heated in a closed crucible, vaikrānta yields its essence. Of this there is no doubt.

71-72

COPPER PYRITES

Mākshikam (pyrites) is born of mountains yielding gold . . . and is produced in the bed of the river Tāpī and in the lands of the Kirātās, the Chinese and the Yavanas. 77

Pyrites is of two kinds—golden and silvery: the former is a native of Kanouj and is of golden yellow colour. The silvery pyrites is associated with stones and is of inferior quality. 81

Rubbed with the juice of lemons and sulphur and roasted in a closed crucible it is killed. 84

Mākshika, repeatedly steeped in honey, oil of the seeds of *ricinus communis*, urine of the cow, clarified butter and the extract of the bulbous root of *musa sapientum* and gently roasted in a crucible, yields an essence in the shape of copper. 89-90

VIMALA

Vimala is described as of three kinds according as it has the lustre of gold, silver and brass respectively. 96

It is rounded and is also endowed with angles and faces. 97

It is killed by being roasted ten times with sulphur, bitumen, *artocarpus lakoocha* and the acids.

100

Vimala, rubbed with borax, the juice of *artocarpus lakoocha* and the ash of *schrebera swiet.*, and roasted in a covered crucible, yields an essence of the appearance of gold. ¹ 101

Vimala digested with alum, green vitriol, borax and the watery liquid expressed from *moringa pter.*, *musā s.* and finally roasted in a covered crucible in combination with the ashes of *schrebera swiet.*, yields an essence in the shape of chandrārka (lit. copper of gold-like lustre). 103-104

SILAJATU

Silajatu (bitumen) is of two kinds, one having the smell of cow's urine, the other resembling camphor. It oozes out in the heat of the sun at the foot of the Himālayas from the bowels of gold, silver and copper respectively.² (cf. *ante* p. 46) 106

(1) The text reads : : भाससानम् — *lead-like*, which however conveys no adequate meaning. A variant is सीतसनिम् : =*gold-like*.

(2) The resins of the *styrax benzoinum* and also a variety of bitumen, especially the latter are referred to. The description is evidently borrowed from the Charaka and the Susruta.

SASYAKA

Sasyaka (blue vitriol) . . . has the play of colour in the throat of the peacock (*i.e.* has blue tint). Mayuratuttham is an emetic, an antidote to poisons and a destroyer of the whiteness of the skin. 127-129

It is killed by being roasted in a covered crucible with the juice of *artocarpus lakoocha*, sulphur, bitumen and borax, 132

EXTRACTION OF COPPER

Take blue vitriol and one-fourth its weight of borax and soak the mixture in the oil expressed from the seeds of *pongamia glabra* for one day only and then place it in a covered crucible and heat in the charcoal fire—by this process an essence is obtained from it of the beautiful appearance of coccinella insect.¹ 133-134

Or, enclosed in a crucible with borax and the juice of lemons and strongly heated, it yields an essence in the shape of copper. 135

Pure blue vitriol, of the colour of peacock, in

(1) *i. e.* red; in the Charka, blood is described as having the colour of the *coccinella* insect. Couplets 133 and 134 have been borrowed almost *verbatim* from Rasarnava.

combination with the aforesaid drugs and by the application of various processes, gives up its essence.

136

CHAPALA

There are four varieties of Chapala—yellow, white, red and black. That which has the lustre of gold or silver is most appropriate for the fixation of mercury. The last two are indifferent and readily melt like lac and are useless. Chapala melts like tin when heated over fire--hence the name.

143-144

Chapala has six faces and the lustre of a crystal.¹

146

RASAKA

Rasaka(calamine) is of two kinds : the one of laminated structure is known as dardura ; the other, non-laminated, is called karavellaka.

149

Calamine is to be heated and plunged seven times into the juice expressed from the seeds of lemon or immersed in the urine of man or of horse or in sour gruel or sour milk and thus purified.

154-155

(1) It is not clear what substance is really meant by the term Chapala ; its radical meaning is mobile or fickle, hence it is a name often given to quicksilver.

EXTRACTION OF ZINC

Rub calamine with turmeric, the chebulic myrobalans, resin, the salts, soot, borax and one fourth its weight of *semicarpus anacardium*, and the acid juices. Smear the inside of a tubulated crucible with the above mixture and dry it in the sun and close its mouth with another inverted over it, and apply heat. When the flame issuing from the molten calamine changes from blue to white, the crucible is caught hold of by means of a pair of tongs and its mouth held downwards and it is thrown on the ground, care being taken not to break its tubulure.¹ The essence possessing the lustre of tin which is dropped is collected for use.

157-161

Calamine is be powdered with lac, treacle, white mustard, the myrobalans, natron and borax and the mixture boiled with milk and clarified butter and made into balls. These are to be enclosed in a crucible and strongly heated. The contents are then poured on a slab of stone—the essence of calamine of the beautiful appearance of tin (thus obtained) is to be used.

163-164

(1) The Benares Ms. reads “शुद्धा नालू भर्तुन्” and drops a which would mean so “as to break its tubulure.”

Or a vessel filled with water is to be placed inside a *koshthī* apparatus and a perforated cup or saucer placed over it; a crucible charged as above is to be fixed in an inverted position over the saucer and strongly heated by means of the fire of jujube (*sizyphus iujuba*) charcoal: the essence which drops into the water should be applied (in medicine). [vide illustrations] 165-166

This essence is to be mixed with orpiment and thrown over an earthen dish and rubbed with an iron rod till it is reduced to ashes. [From the context it is evident that the operation is to be performed over fire.] 167-168.

BOOK III.

THE UPARASAS OR INFERIOR RASAS

Sulphur, red ochre, vitriol, alum, orpiment, realgar, anjana and *kamkushtha*—these are the eight uparasas, useful in operations of mercury. 1

[Here follows the mythical origin of sulphur.]

SULPHUR

Sulphur is of three kinds: that of the first quality resembles the beak of a parrot; that of the second quality is yellow; whereas the white variety is the worst. Another authority says: there are four kinds of sulphur according as it is of white, yellow, red and black colour respectively. ...the black variety is rare.¹

12-15

Melted sulphur is poured into the juice of *verbesina calendulacea* and thus purified.

A vessel which contains milk has its mouth tied down with a piece of cloth, over which is deposited finely powdered sulphur; the latter again covered with an earthen bowl. Heat is applied from above by burning cow-dung cakes. The melted sulphur drops into the milk and is thus purified.

24-25

GAIRIKA

Gairika (red ochre) is of two kinds: the one, pāshāna gairika, is hard and copper-coloured; the other is svarna gairika i.e. of the colour of gold (yellow).

46

(1) Cf .."il y a des soufres des diverses couleurs; l'un rouge, l'autre jaune un autre blanc pariel à l'ivoire;...un autre, noir, qui ne vaut rien." "La Chimie au moyen Âge," 1, 307.

KĀSISA

Kāsisa (sulphate of iron) is of two kinds : vālukā-kāsisa and pushpa-kāsisa. [The former termed in other works dhātukāsisa is the green variety and the latter, the *basic* or yellowish variety.] 51

Its essence is to be extracted like that of alum.

54

TUVARI

Tuvarī (alum) : the fragrant earth produced in the mountains of Surat is known as tuvarī, which dyes cloth and fixes the colour of madder. ¹ 59

A second variety of it called phatakī or phullikā is slightly yellow . . . Another variety known as phulla tuvarī is white and acid in taste ; iron changes to copper by the process of *lepa* [cf. Bk. VIII, 80, where the term “*लेपः*” is used in the sense of transmutation of the baser metals. The author seems to convey the idea that alum plays an important part in this process.] 60-62

Alum is astringent, acid, beneficial to the eye... and *killer* of mercury.²

(1) i.e. forms lakes.

(2) लेपजारण ; Cf. the various formulæ for the preparation of calomel in which alum yields sulphuric acid and plays an important part.

Alum is to be macerated in the bile of the ox one-hundred times and then its essence is to be extracted by distillation¹—a very secret process, not to be divulged.

65

TALAKA

Tālaka (orpiment) is of two kinds: the one is of a leafy structure, the other is found in balls or cakes and is of golden colour . . . and bright.

66

It is purified by being digested in the juice of cucumber, and the alkaline water of the ashes of sesamum or in lime water.

69

Tālaka is to be rubbed with buffalo's urine and thrice macerated in the decoction of *butea frondosa* of the consistency of honey, and then to be roasted in a covered crucible and powdered. This operation is to be repeated twelve times. It is then fit to be used in medicines.²

74-75

Take one pala of tālaka and rub it for one day with the milky juice of *calopropis gigantea* and mix

(1) पातरित सत्रम् ; here distillation is expressly mentioned. Couplet 65 is borrowed from Rasārnava.

(2) Most likely a sulpharsenite of potash is formed. The process in Rasendrasārasamgraha is more scientific. " Tālaka is to be cut into small pieces and rubbed with lime water and the alkaline water derived from the ash of *achyranthes aspera*, and is then to be enclosed in carbonate of potash and roasted."

it with the same weight of oil and heat it in an open place for 7 days and nights together. Collect the white essence when it has cooled down.¹ 80-81

MANASSILA

Manassila (realgar) is mixed with one-eighth part of its weight of iron-rust, molasses, bdellium and clarified butter and enclosed in the koshṭī apparatus [see p. 69] and strongly heated, when it yields its essence. 95

THE ANJANAS

The Anjanas (collyriums): of these there are Sauvīrānjana, Rasānjana, Srotonjana, Pushpānjana, and Nilānjana; their properties are described below.

97-98

Nilānjana is a *killer* of gold [cf. the *killing* of gold, silver, iron and copper in Vāgbhata, p. 55] and induces softness in iron, i.e. readers it easily pulverizable [as the iron becomes impregnated with the brittle sulphide of iron; cf also Bk. viii, 38.]

104

The essence of the anjanas is to be extracted like that of realgar.

(1) It is evident that the operation is to be performed in a glass retort or in the koshṭī apparatus described below under realgar.

[We quote below the account given in Dutt's "Materia Medica of the Hindus" as our author gives rather scanty information on this point :

"Galena or sulphide of lead is called anjana or sauvirānjana in Sanskrit, and krishna surma in vernacular. It is called anjana which literally means collyrium or medicine for the eyes, from the circumstance of its being considered the best application or cosmetic for them. The other varieties of anjana mentioned are Srotonjāna, Pushpānjana and Rāsānjana.

"Sauvirānjana (सौविराञ्जन) is said to be obtained from the mountains of Sauvira, a country along the Indus, whence it derives its name. The article supplied under its vernacular name surma is the sulphide of lead ore. Sauvira is usually translated as sulphide of antimony, but I have not been able to obtain a single specimen of the antimonial ore from the shops of Calcutta and of some other towns. The sulphide of antimony occurs in fine, streaky, fibrous, crystalline, masses of a radiated texture: The lead ore on the contrary occurs in cubic masses destitute of rays and is tabular in its crystalline arrangement.

"Srotonjana (स्रोतोञ्जन) is described as of white colour, and is said to be produced in the bed

of the Yamunā and other rivers. It is called Saffed Surma in the vernacular, and the article supplied under this name by Hindustani medicine-vendors is calcareous Iceland spar.¹ It is used as a collyrium for the eyes, but is considered inferior to the black surma or galena.

"Pushpānjana (पुष्पाञ्जन) is described as an alkaline substance. I have not met with any vernacular translation of this word nor with any person who could identify or supply the drug. Wilson, in his Sanskrit-English Dictionary, translates the term as calx of brass, but I know not on what authority.

"Rasānjana (रसाञ्जन) is the extract of the wood of *berberis Asiatica* called *rasot* in the vernacular."]

Kāmkushtham is produced at the foot of the Himalayas . . . Some are of opinion that it is the excrement of a new-born elephant . . . it is of white and yellow colour and is a strong purgative.²

109-112

(1) See, however, *ante* p. 55.

(2) Not well made out. According to Wilson, it is a medicinal earth, described as of two colours, one of a silvery and the other of a gold colour.

THE COMMON RASAS

Kampilla, Chapala¹ Gauripāshāna, Navasāra-ka, Kaparda, Agnijāra, Hingula, Girisindūra, Mrid-dārasringakam : these are the eight common Rasas regarded as useful adjuncts to chemical operations by Nāgārjuna and other experts. 120-121

Kampilla² is like brick-dust . . . a purgative . . . natural product of Surat . . . and a vermifuge.

Gauripāshāna³ is of the lustre of rock-crystal, conch and turmeric respectively . . . its white essence is to be extracted like that of orpiment.

124-125

NAVASARA AND OTHER RASAS

Navasāra (sal ammoniac) is begot of the decomposition of the shoots of bamboos and of the wood of *careya arborea*; navasāra is an alkali, its another name is *chulikālavana* (lit. salt deposited in

(1) Including Chapala there are nine common Rasas; but Chapala has already been considered as a mahārasa. (see p. 87)

(2) The red mealy powder covering the capsules of *mallotus Phillipensis*, also known as kamalā. It is not clear why this substance should have found a place among the products of the mineral kingdom.

(3) Not easy to identify; lit., it means white stone or marble.

the hearth), it is produced during the burning of the brick . . . it kills mercury, liquefies iron, is a stomachic, an absorbent of the spleen, and aids digestion after much eating.¹ 127-129

Varātaka (cowrie or marine shell): alchemists prefer shells which are of yellow colour, knotty and possessed of circular lines on the dorsal side

macerated for three hours in sour gruel, it undergoes purifications.² 130-134

Agnijāra is a substance discharged from the

(1) It is of interest to note that Royle, who wrote in 1837, regrets that "no Hindu work on this subject (chemistry) has yet been translated" and is bold enough to predict that "Sal ammoniac must have been familiar to the Hindus, ever since they have burnt bricks, as they now do, with the manure of animals as some may usually be found crystallized at the unburnt extremity of the kiln."—"Antiquity of Hindu Medicine." Royle's surmises have proved to be literally correct. The word "*Navasára*" is apparently of Persian origin being corrupted from "*Nausadar*."

(2) The text is almost exactly the same as in "Rasendrasára-saṅgraha," which gives an additional method of purifying the cowrie, namely:—"Dig a hole in the ground and fill it partly with the husk of paddy, now place on it a crucible containing cowries; cover it with cow-dung cakes and set fire to the mass. By this process the cowries are reduced to ashes." It is the lime thus obtained, which is often used in medicine.

womb of a kind of sea-crocodile and dried in the sun.¹

135

Girisindūra (lit. vermillion derived from the rocks) occurs among the big mountains (inside the rocks).

137

Hingula (cinnabar : Syn. darada, see p.78) ; quicksilver extracted from it is as efficacious as killed sulphur. When darada is placed in a retort and its essence collected in water, it yields the same substance as quicksilver—of this there is no doubt. (The apparatus referred to is shown in the illustrations).

141-144

Mriddarasringakam [various readings of the text are given ; it is not easy to make out what substance is meant]. It is yellow and of leafy structure and occurs in Gujārat and round about mount Abu.

145

Rājavarta (Lapis lazuli) has a bluish tint but with slight admixture of red.....it is killed by being powdered in combination with lemon juice and sulphur and roasted 7 times in a covered crucible.

149-153

(1) Not identified. Perhaps the origin is mythical. नर्म is a crocodile, but as is well-known this Saurian never flourishes in the sea. According to राक्षस निषेध agnijāra is a marine medicinal plant.

BOOK IV

THE GEMS

The gems also are regarded as the agencies, which help the fixation or coagulation of mercury. These are the gems : Vaikránta, Suryakánta (sun-stone), Hirakam (diamond); Mauktikam (pearls), Chandrakánta (moon-stone), Rājāvarta (lapis lazuli) and Garudogara, the emerald (lit. derived from the vomit of Garuda); the topaz, the sapphire, the coral, the cat's eye are also reckoned among the gems. These are to be carefully collected for the fixation of mercury.¹

(1) The ruby and the zircon are also mentioned. The Vaikránta "is a kind of gem said to resemble a diamond, and to be of similar properties." Wilson. Suryakánta and Chandrakánta are gems of fabulous existence, supposed to be formed by the congelation of the rays of the sun and moon respectively. They may also refer to some sort of crystals. The description of the gems, other than diamond, is meagre and vague. The following extracts from Manimála or "A Treatise on Gems" by Sir Raja Saurindra Mohan Tagore, Mus. Doc., will, to a certain extent, make up for the deficiencies.

"Mention is made of gems and jewels in the earliest writings of the Hindus. The Vedas speak of a place illuminated by rubies and diamonds, which gave out a light as resplendent as that of the planets. Precious stones play a prominent part in the mythologies

VAJRAM

Vajram (diamond) is of three kinds: male, female and hermaphrodite, and its medicinal properties vary in excellence in the order in which they have been spoken. 26

The one with 8 angles and 8 faces and 6 corners, very brilliant, with the play of rainbow-colours¹ is known as the male diamond, whereas the female diamond is flattened and rounded whilst the neuter is rounded, obtuse-angled and slightly heavy:

27-28

Each of these again is divided into 4 classes according to its colour namely: Brāhmaṇa, Kshatriya, Vaisya and Sūdra.² 30

of the Hindus, in their traditions, poems and legends. In the two great epics of Hindustan, the Rāmāyaṇa and the Mahābhārata, frequent mention is made of stones and pearls with which the kings and the people of the period used to decorate their person."

(1) The high refractive and dispersive power of diamond is evidently referred to.

(2) "Diamonds white like the conch, waterlily, or crystal are Brāhmaṇas; those which are red like the eyes of the hare are Kshatriyas; those which are verdant like the cool plantain-leaf are Vaisyas; those which resemble in colour the clean sword, are known as Sudras." Mānimāla, 1.100.

Diamond is a bestower of long life, a tonic, an allayer of the three derangements [namely, of air phlegm and bile], a killer of all the ailments, a fixer of mercury, a subduer of death—in short it is like nectar.

Diamond is digested in the decoction of kulattha (*dolichos uniflorus*) or of kodrava (*paspulum scrobiculatum*) for three hours and thus purified. Diamond is to be macerated four times in the blood of the bug and enclosed in a ball made of the flesh of the musk-rat and then to be roasted in a covered crucible 30 times or to be heated 100 times and plunged in the decoction of kulattha. 34-37

Diamond is to be placed in a covered crucible, the inside of which has been coated with realgar, rubbed with the decoction of kulattha and the juice of *artocarpus lakoocha* and roasted 8 times in succession in the fire of dry cow-dung cakes. It is then heated 100 times and thrown into pure mercury—the diamond is thus killed and reduced to fine ashes. 38-39

The veracious alchemist Somasenānī, after having convinced himself of the success of this process by his own experiments, has given it to the world.

40

Diamond is to be 7 times smeared in the blood

of the bug and dried in the sun and then to be placed in an iron pot and filled with the juice of *cassia sophora* and heated 7 times. The diamond is sure to be reduced to ashes. This process has been described by the sage Brahmajyoti. 41-42

Diamond smeared with the powder of lead, levigated in the juice of the fruit of madana (*randia dumetorum*), and roasted 20 times in a covered crucible; is reduced to fine powder; which is to be used in medicines.¹

GENERAL PROCESS OF REDUCING GEMS TO ASHES

All the gems with the exception of diamond are killed when roasted eight times with a mixture of realgar, sulphur and orpiment, rubbed in the juice of *artocarpus lakoocha*. 63

Take asafoetida, the five salts, the three alkalies, *rumex vesicarius*; sal ammoniac, the ripe fruit of the croton plant; *jälämukhi* (*anthericum tuberosum*), rudanti (*asclepias rosea*), the root of *plumbago zeylanica*, and the milky juice of *euphorbia antiquorum* and *calotropis gigantea*—rub all

(1) One or two processes not mentioned by our author may be quoted from "Rasendrachintāmanis":—

these together and make them into a ball. Place inside it the noble and luck-yielding gems. Wrap the ball with the leaves of betula bhojpattra and tie them with thread and enclose the ball again in a piece of cloth and suspend it in a dolāyantra (see Bk. ix) filled with the acids and sour gruel and apply strong heat for three days and nights—the liquid principle of the gems is thus collected.

64-69

Powdered pearl is to be rubbed with the juice of *rumex vesicarius* and then transferred inside a lemon and stowed in a mass of paddy. At the end of a week it is heated in a crucible and liquefied.¹

70-71

"Take the root of *piper betle* or of the cotton plant (*Gossypium herbaceum*) three years old, and rub it into a paste and enclose the diamond in it and roast it in a covered crucible seven times, when the diamond will be killed."

"An intelligent person should place in a brass vessel a frog which out of fright will pass water. A diamond is to be heated and plunged into this urine. This process being repeated several times, the diamond is killed." This last recipe is also to be found in Sarngadhara. Couplets (44-45) do not occur in the Benares Ms.

(1) Couplets 70, 71 and 72 do not occur in the Benares Ms

Diamond, placed inside the stem of *vitis quadrangularis*¹ and heated four weeks in acids, is liquefied. 72

Vaikrānta, which is of white colour, liquefies when macerated in the juice of *rumex vesicarius* and exposed to the sun for a week. 73

— Take the juice of *pandanus odoratissimus* rock-salt, svarna pushpikā together with *coccinella* insect. Vaikrānta melts on being digested in this concoction for a week. 74

BOOK V

ON METALS² (लोहानि)

The pure metals are: gold, silver, and iron. The putilohas (lit. metals emitting a foetid odour) are two: lead and tin. Dhātuloham is iron proper and often conveys different meanings. The alloys are three in number: brass, bell-metal and vartaloha. I

(1) वज्रवस्त्री according to "Vaidyakasabdasaṅdhū" is the same as विश्वरूपारक्षा i.e. *vitis quadrangularis*.

(2) Loha (lit. iron) is often used in the wider sense of a metal.

GOLD

Gold is known to be of five kinds :—of which 3 are attributed to mythical and celestial origin ; the fourth is called *kshanija* (lit. begot of mines) : the 5th is obtained by the transmutation of the baser metals. (See Bk. VIII, 80-83.) 2

Gold is to be purified and killed, as otherwise [if taken internally] it robs one of strength, virility and happiness and brings a series of maladies. 11

Gold-leaf of the weight of one *karsha* is to be smeared with salt and placed between two earthen saucers and heated on a charcoal fire for an hour and a half when its true colours will come out. 12

The best method of *killing* all the metals is with the aid of the ashes of mercury.¹ The next best is through the agency of the roots, whereas *killing* with sulphur is least to be recommended. 13

When a metal is *killed* with *ariloha* (meaning : not clear), it is injurious. Gold-leaves, pierced with holes and coated with a paste of lemon juice and the ashes of mercury and roasted ten times are thereby *killed*. 14

Project into melted gold its own weight of the ash of mercury ; [when cooled] powder it and rub

(1) Generally sulphide of mercury (see p. 65).

it with lemon-juice and cinnabar and roast it in a covered crucible twelve times. The gold thus acquires the colour of saffron.¹ (cf. Rasārnava xvi. 81, p. 74). 15-16

Gold-leaf is killed by being rubbed with one-fourth of its own weight of *killed* mercury and acid of any kind and roasted eight times.² 17

SILVER

Silver is of 3 kinds : namely sahajam (of mythical origin), begotten of mines and artificial. 22

Silver melted with lead and borax undergoes purification Arrange on an earthen dish a mixture of lime and ashes in a circular row and place in it silver with its equal weight of lead. Now roast it over fire until the lead is consumed. Silver thus purified is to be used for medicinal purposes.)³ (Cf. p. 68) 32-34

(1) This refers to the mistaken notion that the sublimate of factitious cinnabar (vermilion) contains gold.

(2) It will be seen that although *killing* with sulphur direct is not recommended, the gold is in reality converted into the sulphide and afterwards into metallic gold in a fine state of powder. See under "Killing of Metals."

(3) Cf. Rasārnava नारोन चारराजेन द्रावितंशुहिष्कृति "Silver is purified by being melted with lead and the ashes." The process is practically that of cupellation.

Silver-leaf is to be rubbed with mercury and the juice of *artocapus lakoocha* and is to be embedded in sulphur and heated in a covered crucible over a sand-bath; when cold, the mass is once more rubbed with orpiment and acids and roasted 12 times. By this process, the silver is reduced to ashes

35-37

Silver is reduced to ashes by being 3 times rubbed with powdered iron pyrites and lemon juice and roasted in a covered crucible.

38

Take 4 parts of silver-leaf and one of orpiment and rub them with the juice of lemon and roast the mixture and repeat the operation 14 times and thus silver is completely incinerated.¹

40-41

COPPER

There are two varieties of copper: the one brought from Nepal is of superior quality; that dug out of the mines of other countries is designated Mlechchha.

44

(1) We shall complete the account with an extract from *Rasendrasarasamgraha*: "Silver-leaf is pierced with holes and smeared with twice its weight of cinnabar and subjected to distillation in the Pátana Yantra (see Bk. IX on apparatus). The mercury comes off and *killed* silver remains behind."

(2) The generic term for a barbarian or a foreigner.

Copper-leaf is killed by being rubbed with lemon-juice, sulphur and mercury and roasted thrice

55

IRON

There are three kinds of iron : namely, mundam (wrought iron), *tikshnam* and *kāntam*; mundam again is of 3 varieties : viz., *mridu*, *kuntham* and *kadāram*.

That which easily melts, does not break and is glossy is *mridu*; that which expands with difficulty when struck with a hammer is known as *kuntham*; that which breaks when struck with a hammer and has a black fracture is *kadāram*. 71-72

Tikshnam (properly cast-iron, steel) : there are 6 varieties of it. One variety is rough and free from hair-like lines and has a quicksilver-like fracture and breaks when bent. Another variety breaks with difficulty and presents a sharp edge.

75-78

Kāntam : there are 5 kinds of it, namely, *bhrāmaka*, *chumbaka*, *karshaka*, *drāvaka* and *romākānta*. It possesses one, two, three, four and five faces and often many faces [with which to attract iron] and is of yellow, black and red colour respectively. The variety which makes all kinds of iron move about is called *bhrāmaka*, that which kisses

iron is called chumbaka, that which attracts iron is called karshaka, that which at once melts the iron is called drāvaka (lit. a solvent) and the fifth kind is that which, when broken, shoots forth hair-like filaments.

84-89

Mercury is like an intoxicated elephant and kāntam is like the bent hook wherewith to restrain it. The wise man digs it out of the mines. That which has remained exposed to the sun and the atmosphere is to be avoided.'

92-93

If water is kept in a vessel and oil poured over it and the oil does not spread about; if asafœtida gives up its odour and decoction of neem (*Melia azadirachta*) its bitterness and milk, being boiled in it, does not overflow but rises high like a peak —if such be the characteristics of the vessel, know that it is made of kānta iron.

94

Powdered iron is to be macerated awhile in the decoction of the three myrobalans, in cow's urine and then to be mixed up with clarified butter and fried in an earthen vessel and stirred with an iron rod until a blade of straw thrown over it catches fire. The iron powder is to be pounded and the above process repeated five times.

(1) Couplets 84-93 are taken bodily from *Rasānava*.

Or iron is roasted four times in a covered crucible with the decoction of the myrobalans and is reduced to fine powder.¹

104-105

Leaves of *tikshna* iron are repeatedly to be heated and plunged into water and then to be powdered in a stone mortar with an iron pestle
 * * * The powder of iron thus obtained is to be roasted twenty times in a covered crucible in combination with mercury and sulphur, and after each roasting the powder of iron is to be pounded as directed above—iron thus reduced to ashes is to be used in medicine.

107-110

Take one part of iron and twentieth part of its weight of cinnabar and rub them with lemon juice and sour gruel and roast the mixture in a covered crucible. The operation being repeated 40 times, *kāntam*, *tikshnam* and *mundam* are killed—of this there is no doubt.

113-114

Take of mercury one part, sulphur two parts and iron powder three parts and rub them with the juice of the Indian aloe and after 6 hours transfer the mass to a brass-vessel and cover it with the leaves of the castor-oil plant. At the end of an hour and a half the mass will become heated. It is

(1) The process is practically the same as that of Chakrapāni, who ascribes it to Nagārjuna. (See p. 62.)

then buried under a heap of paddy grains and taken out after three days and then powdered very fine and the contents passed through linen.¹ All the three varieties of iron are thus completely killed. Gold and other metals can be killed by this process after being reduced to fine powder like iron.

134-137

Rust of iron is to be heated and powdered till it is reduced to fine powder—this is called *mandūra*.²

147

The qualities which reside in killed iron are also to be found in the rust of iron, hence the latter may be substituted for the treatment of diseases.³

148

TIN

Vangam (tin) is of two kinds—*kshurakam* and *misrakam*; the former is endowed with superior qualities; the latter cannot be recommended for medicinal uses.

153

(1) "Rasendrasārasamgraha" has the same recipe with slight variations. According to it the powder is so fine that it "floats on water like a duck." Cf. below p. 119.

(2) Analysis of "Mandūra"; see Appendix I.

(3) This couplet also occurs in *Rasendrasārasamgraha*.

Kshurakam is white, soft, cool (to the touch), readily fusible and bright and does not clink (when struck). 154

Misrakam is dirty white * * * This is an anthelmintic and a destroyer of the urinary disorders. 155

Molten tin is dropped into the juice of *Negundo vitex* mixed with turmeric; the process being repeated 3 times, the metal undergoes purification..

154-156

Tinfoil is to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and then to be covered with the ashes of the bark of *Ficus religiosus* and *Tamarindus Indicus* and roasted and then reduced to ashes.¹

LEAD

Sisakam (lead) is readily fusible, very heavy.

(1) A few more recipes are given, in all of which orpiment plays an important part; the one quoted below from Rasendra-sarasamgraha will yield the "ash" of tin in the shape of an oxide. "Melt tin in an earthen pot and to the molten metal add an equal weight of powdered turmeric and Ajowan (*Picrosia ajowan*) and cumin seeds, and afterwards the ashes of the bark of *Tamarindus Indicus* and *Ficus religiosus* and continue stirring over fire. The tin will be reduced to ashes."

presents a black and bright appearance on fracture,
is of foetid odour¹ and black exterior. 171

Take of lead 20 palas and apply strong heat
to it and drop into the molten metal one karsa of
mercury and throw into it one after another the
ashes of *Terminalia arjuna*, *T. bellerica*, pome-
granate and *Achyranthes aspera*, weighing one
pala each. The mass being vigorously stirred with
an iron spoon for 20 nights in succession, the metal
is calcined yielding a bright red ash.² 176-179

(1) Lead and brass (see below) are said to emit an offensive
odour. In connection with this it is interesting to read Professor
W. E. Ayrton's address "On the Smell of Metals"—Brit. Assoc.
Rep. 1898, p. 772. Cf. also "Alch. Syr." Trad., 121, as well as the
opening lines of the present Book describing tin and lead "as
metals of foetid odour." In the Syrian Alchemy "Silver is dis-
tinguished from tin by its absence of foetid odour"; regarding this
M. Berthelot very pointedly remarks: "on voit que l'odeur propre
que dégagent les mémaux frottés avec la main, ou bien au contact
d'une matière organique, jouait un rôle important dans leur étude
chez les anciens auteurs; importance que cette odeur a perdue
aujourd'hui.—"La Chimie au moyen Âge": T. ii. 121 (trad.)

(2) The following process is given both in the "Rasendrá-
chintámaní" and "Rasendrasársamgraha": "Rub lead with the
juice of *Adhatoda vasica* and melt it in an earthen pot add to it one
fourth its weight of the ashes of *Adhatoda* and *achyranthes aspera*
and stir the mass with a rod *Adhatoda vasica* and heat over a fire.
Repeat the process seven times. The lead will be turned to
vermilion-like powder."

Leaves of lead are to be smeared with a paste of orpiment and the milky juice of *Calotropis gigantea* and roasted in a covered crucible till the metal is entirely killed. 184

BRASS, BELL-METAL, &C.

Pittala (brass) is of 2 kinds—ritikā and kākā-tundī; the former on being heated and plunged into sour gruel turns copper-coloured. 192-193

Brass, which is heavy, soft, of yellow colour, capable of resisting strokes, is to be recommended.

195

Brass, which is light and of effusive odour, is not good for medicinal purposes. 196

Brass, smeared with a paste of lemon juice, orpiment and sulphur and roasted 8 times, is reduced to ashes. The process of killing brass is the same as that of copper. 201-202

Kāmsya (bell-metal) is made by melting together 8 parts of copper and 2 parts of tin. 205

It is completely killed by being roasted 5 times with sulphur and orpiment. 210

Vartaloham is produced from Kāmsya, copper, pittala, iron and lead; hence it is regarded by metallurgists as an alloy of 5 metals..... It is killed with the aid of sulphur and orpiment.

212-216

HINDU CHEMISTRY

BOOK VI

INITIATION INTO DISCIPLESHIP

[This chapter is full of directions for the mystic Tāntric rites after the performance of which the pupil is to be initiated into the secrets of mercurial lore.]

The instructor must be wise, experienced, well-versed in chemical processes, devoted to *Siva* and his consort Pārvatī sober and patient. The pupil should be full of reverence for his teacher, well-behaved, truthful, hard-working, obedient, free from pride and conceit and strong in faith. 3-7

Chemical operations are to be performed under the auspices of a ruler, who is God-fearing, who worships *Siva* and Pārvatī and whose territory is free from anarchy; and the Laboratory, to be erected in the depth of a forest, should be spacious, furnished with 4 doors and adorned with the portraits of the Gods. 13-15

Take of gold-leaf 3 *niskas* in weight and quicksilver 9 *niskas* and rub them with acids for 3 hours. Make the amalgam into a *phallus* (emblem of *Siva*, the creative principle).....the *phallus* to be worshipped in due form. By the mere sight

of the *phallus* of mercury, the sins accumulated by the killing of 1,000 Brāhmans and 10,000 cows are redeemed.

19-22

The science of mercury was communicated by Siva himself and is to be imparted by the instructor to the disciple according to the prescribed rules with closed eyes.

30

[Here follows an account of certain disgusting and obscene rites borrowed from Rasārnava and other Tāntric works.]

The apparatus and implements as also the ingredients required for chemical operations (see next Book) are also to be addressed in prayer

. and the names of the 27 alchemists to be invoked. [See opening lines : Bk. I, p. 77.]

53-61

The science of mercury is to be strictly kept a secret . . . if it is divulged, its efficacy is gone

70

BOOK VII

ON THE LABORATORY

The Laboratory is to be erected in a region, which abounds in medicinal herbs and wells . . .

HINDU CHEMISTRY

. . . it is to be furnished with the various apparatus. The *phallus* of mercury is to be placed in the east, furnaces to be arranged in the south-east, instruments in the south-west; washing operations in the west; drying in the north-west. .

. The koshṭī apparatus for the extraction of essences, the water vessels, a pair of bellows and various other instruments are also to be collected as also the threshing and pounding mortars, the pestles, sieves of various degrees of fineness, earth for the crucibles, charcoal, dried cow-dung cake, retorts made of glass, earth, iron and conch-shells,¹ iron-pans, &c.

1-18

Those who are truthful, free from temptations, given to the worship of Devas and Brāhmaṇas, self-controlled and used to live upon proper diet and regimen—such are to be engaged in performing chemical operations.

30

Such herbalists as are not deceitful and are well-versed in the knowledge of the drugs and plants and in the language of many countries should be employed.

32

(1) Probably lime crucibles and retorts are meant.

BOOK VIII

ON TECHNICAL TERMS

For the comprehension of ignorant physicians, Somadeva¹ is now expounding the technicalities as made use of by experts.

1

The physician is entitled to half the share of prepared mercury and eighth part of medicated oils and *ghee* and seventh part of prepared iron and other metals.

2

Mercury, on being finely rubbed with melted sulphur and other minerals, attains the tint of collyrium and is called *kajjali* (see p. 61), which again on being rubbed with a liquid substance is known as *Rasapanka* (lit. mud of mercury).

5-6

TESTS FOR KILLED IRON.

Killed iron is that which in the shape impalpable powder floats on water and when rubbed between the thumb and the fore-finger enters the lines :· which, on being mixed with treacle, *abrus p.*, honey

(1) The author evidently reproduces this chapter from a standard work on the subject by Somadeva. There is a work

and *ghee* and heated, does not revert to the natural state; which floats on water like a duck and does not sink down even when heavy things like paddy grains are placed over it. (Cf. *ante* p. 111, foot-note).

25-28

Killed iron (or a general in *killed* metal) is that which on being heated with silver does not mix (or alloy) with it.¹

29

ANTIMONY FROM STIBNITE

Nilāñjana,² mixed with tikshnam (cast iron) and strongly heated several times, yields a superior kind of lead which is readily fusible and is of mild black colour.

38

[Here follows a list of metaphorical expressions which are technically used.]

named Rasendrachūdāmani by Somadeva. We hope to notice it in the second volume.

(1) The Poona ed. has रौप्यम् चेष्टत् *mixes with silver*; but the Benares and the Kāsmīr MSS. read रौप्य न चेष्टत् *does not mix with silver*. The latter is no doubt the correct reading.

(2) Stibnite. A synonym for it is souvirāñjana. The "superior kind of lead" is evidently antimony.

CERTAIN OTHER TECHNICAL TERMS

The resurrection of the dead is known as *utthāpana* (lit. raising).¹ 39

The capacity of mercury to swallow food [i. e. to combine with certain substances or to take up the qualities inherent in them] is known as *grāsa-mānam*. 64

Mercury, alloyed with one-sixty-fourth part of its weight of gold or silver, acquires a mouth whereby to swallow even hard metals. 68-69

Lepa, *kshepa* and *kunta* signify *dhūma* i. e. smoke. By the process of *lepa* is meant the conversion of iron into gold or silver. 80

The conversion of iron into gold or silver with the aid of mercury thrown into a smoky flame, emitting vapour, is known as *dhūmavedha* (lit. pierced by smoke). 83

The conversion of a small quantity of a metal into gold through the agency of mercury. which has acquired a mouth (see sloka 68), is called *sabdavedha*.² 84

(1) e.g., the conversion of *killed* iron into the metallic state.

(2) It is to be regretted that the details of the processes have been withheld. We have here sufficient indication of the belief in the transmutation of metals. The processes here mentioned are probably of the same nature as given in *Rasārnava*.

Somadeva collected these brilliant gems of technical terms with great care from the ocean of mercurial lore and strung them into a necklace which adorns the best of physicians in assemblies.

89

BOOK IX

ON APPARATUS THE (YANTRĀS)¹

Somadeva will now give a brief account of the apparatus after having consulted innumerable works on chemistry.²

I

DOLĀ YANTRAM

Dolā yantram : a pot is half-filled with a liquid and a rod placed across its mouth from which is suspended the medicine tied in a piece of cloth. The liquid is allowed to boil and a second pot³ inverted over the first.

3-4

(1) *Vide* illustrations : Appendix II.

(2) This chapter also is evidently quoted from the work of Somadeva.

(3) Unless otherwise stated earthen pots are meant.

SVEDANĀ YANTRAM

Svedanī yantram: a pot with boiling water has its mouth covered with a piece of cloth and the substance to be steamed is placed on it and a second pot arranged in an inverted position over the rim of the first.

5

PĀTANĀ YANTRAM

Pātanā yantram [lit. apparatus for sublimation and distillation] : two vessels are adjusted so that the neck of the one fits into that of the other. The junction of the necks is luted with a composition made of lime, raw sugar, rust of iron and buffalo's milk. [Tedious details are given as to the exact measurement of the vessels.]

6-8

ADHASPĀTANA YANTRAM

Adhaspātanā yantram: a modification of the above apparatus in which the bottom of the upper vessel is smeared with the substance, the vapour or essence thereof condensing into the water of the lower one. Heat is applied on the top of the upper vessel by means of the fire of dried cow-dung cakes.

9

DHEKİ YANTRAM

Dhekī yantram : below the neck of the pot is a hole into which is introduced the upper end of a bamboo tube, the lower end of it fitting into a brass vessel filled with water and made of two hemispherical halves. Mercury mixed with the proper ingredients is subjected to distillation till the receiver gets sufficiently heated. 11-14

VĀLUKĀ YANTRAM (SAND-BATH)

Vālukā yantram (sand-bath : a glass flask with a long neck containing mercurials, is wrapped with several folds of cloth smeared with clay and then dried in the sun. The flask is buried up to three-fourths of its length in sand and placed in an earthen pot whilst another pot is inverted over it, the rims of both being luted with clay. Heat is now applied till a straw placed on its top gets burnt. 34-36.

LAVANA YANTRAM

If in the above apparatus salt is substituted for sand, it is called lavana yantram (salt-bath). 38.

NĀLIKĀ YANTRAM

If in the above an iron tube be substituted for the glass flask, it is called *nālikā yantram*. 41

Place the crucible containing chemicals inside a mass of sand and apply heat by means of cow-dung cakes. This is known as the *Bhūdhara yantram*.

TIRYAKPĀTANĀ YANTRAM

Tiryakpātanā yantram (lit. distillation *per descensum*) : place the chemicals in a vessel provided with a long tube, inserted in an inclined position, which enters the interior of another vessel arranged as receiver. The mouths of the vessels and the joints should be luted with clay. Now urge a strong fire at the bottom of the vessel containing the chemicals, whilst in the other vessel place cold water. This (process) is known as *tiryakpātanām*. 48-50

VIDYĀDHARA YANTRAM

Vidyādhara yantram is for the extraction of mercury from cinnabar. [Two earthen pots are

arranged as in the illustration. The upper one contains cold water and the mercury condenses at its bottom.]

57-58

DHŪPA YANTRAM

Dhūpa yantram (lit. fumigating apparatus) : bars of iron are laid in a slanting position a little below the mouth of the lower vessel and gold-leaves are placed over them and at the bottom of the vessel is deposited a mixture of sulphur, realgar, orpiment, etc., A second vessel, with its convexity turned upwards, covers the mouth of the lower one and the rims are luted with clay. Heat is now applied from below. This is called fumigation of gold-leaves. Silver may also be similarly treated.

70-74

[This chapter concludes with a detailed description of mortars and pestles—their sizes, measurements, &c.]

BOOK X

ON THE INGREDIENTS FOR CRUCIBLES, &c.

Earth which is heavy and of a pale colour, sugar or earth from an ant-hill or earth which has

been mixed with the burnt husks of paddy, fibres of the hemp plant, charcoal and horse-dung pounded in an iron mortar and also rust of iron are to be recommended for crucible-making. 5-6

VRINTAKA CRUCIBLE

A crucible of the shape of the fruit of brinjal (*Solanum melong*) to which is attached a tubulure, which is expanded towards its mouth like the flower of *Datura s.*, . . . and which is either 12 or 8 digits in length, is suitable for the extraction of the essence of calamine and other readily fusible minerals. 23-24

[The particular kind of crucible described here is the same as referred to in the extraction of zinc from calamine in the couplets 157-161, Bk. II.]

[Here follows a tedious account of the different kinds of crucibles to be used for different chemical operations.]

CALCINATION, ROASTING, &c.

When metals have undergone roasting they cannot be roasted to their former condition (*i.e.* they lose their own properties) and they acquire

superior qualities, fill up the lines in the fingers and do not sink in water.¹

51

A quadrangular pit 2 cubits in length, breadth and depth respectively is filled with 1,000 cow-dung cakes. The drugs to be roasted are placed in one crucible; this is covered with a second, the rims being luted with clay. The crucibles are deposited over the cow-dung cakes and 500 more thrown over them: fire is now applied.

54-55

[The description given above is that of a typical roasting pit. The size of the pit, as also the number of cow-dung cakes often varies according to requirements. It is unnecessary to reproduce the *minutiae*.]

THE METALS

The six metals are: gold, silver, copper, tin, lead and iron. Kāmsya and pittala (see p. 114) are artificially made [*i.e.* alloys].

70

THE SALTS

The six salts are: sāmudram (lit. derived from the evaporation of sea-water); saindhava (or rock-

(1) Cf. VIII. 25-28; also ibid. 39, pp. 118-119.

salt) ; *vidam*, *sauvarchala*, *romaka* and *chulikā lavana*.¹

THE ALKALIES

The 3 alkalies are : carbonate of potash, carbonate of soda (trona or natron) and borax. 71

THE OILS

[A list of plants is given from the seeds of which oil is expressed.] 73-75

THE FATS

The fats of the jackal, the frog, the tortoise, the crab, the dolphin, the ox, the pig, man and also of the goat, the camel, the ass, the ship and the buffalo are to be used. 76-77

THE URINES

The urines of the elephant, the she-buffalo, the ass and the horse are to be used. (Cf. *ante* p. 30). 78

THE ACIDS

The acids are : *rumex vesicarius*, the citrons

(1) A syn. for *navasāra* (salammoniac), see p. 97.

and lemons, *oxalis corniculata*, tamarind, the acid exudation of *cicer arietinum*, *zizyphus jujuba*, pomegranate, *averrhoa carambola*—these are the acids well suited for the purification, dissolution and killing of mercury and the minerals.¹ 80-84

THE EARTHS

Brick, red ochre, saline deposits, ashes, earth from ant-hills—these 5 kind of earth are recommended by the experts. 85

THE POISONS

Kālakuta, aconite ferox, sringika and the biles of animals are the chief poisons. 86

The minor posions are :—*gloriosa superba, strychnos nux vomica, nerium odoratum, anacardium semicarpus, datura stramonium, calotropis gigantea*.²

(1) See under Mineral Acids.

(2) The information on the poisons is most elaborate in Susruta from whom our author evidently borrows the classification as given later on in Bk. XV; namely : खाद्यः, वर्षमः, क्रिमः or vegetable, animal and artificial poison. It is worthy of note that opium is not included among the minor poisons.

THE SOLVENTS

Treacle, *bdellium*, *abrus precatorious*, clarified butter, honey, borax—these are used for helping the fusion of the most infusible metals and hence they are classed among the solvents. 100

BOOK XI

ON THE PURIFICATION OF MERCURY

I am now going to describe briefly the various processes for the purification of mercury after having consulted Rasārnava and other works. 10

There are 3 natural impurities in quicksilver, visha (poison), vanhi (fire) and mala (dirt, dregs) and two artificial, due to its being alloyed with lead and tin.¹ 14-15

(1) Cf. Rasendrachintāmani.

मिश्रितौ चेद्दसे नागवङ्गौ विक्षयहेतुना ।

ताभ्यां स्थात् क्रिमोदोषः तन्मुक्तिः पातनचयात् ॥

"Trades-people fraudulently adulterate quicksilver with lead and tin, hence it is to be freed from these artificial defects [impurities] by means of three distillations" as given above under Tiryakpátaná (p. 124).

Hence for the purification of mercury, the operations (named below) are to be undertaken with the aid of appliances and skilled assistants. 20

In an auspicious day and under the influence of a benign star, a quantity of mercury weighing 2,000 or 1,000 or 100 or 18 or 10 *palas* is to be taken and the operation begun. 21-22

[It is useless to enter into the details of the several processes described here ; they are more or less repetitions of what has already been given.]

Pātanavidhi : [purification of mercury by distillation as described in the foot note p. 130.] 33

FIXATION OF MERCURY.

Rasavandha : processes for destroying the fluidity of mercury :

Take mercury and one-fourth its weight of *killed* gold and with the addition of sulphur make a ball. Now add an equal weight of sulphur and roast the mass in a covered crucible.¹ 72

The mercury thus treated is afterwards killed

(1) In other works a glass retort is recommended.

with six times its weight of sulphur.¹

73

INCINERATION OF MERCURY

[The chapter concludes with certain recipes for the killing of mercury, with the aid of purely vegetable products.]

Mercury, roasted in a covered crucible with asafœtida, which has been previously digested in the milky juice of *ficus oppositifolia*, is reduced to ashes.²

III

Andropogon serratus and *clitorea ternata* are to be pounded in a mortar with sour gruel and with the paste thus formed, mercury is to be triturated and digested 7 times and finally roasted in

(1) The shining reddish brown crystalline sublimate of sulphide of mercury thus obtained is a favourite and frequently-used remedy with the Hindu physicians. It is reputed to be a panacea for a variety of ills that flesh is heir to. In the "Rasendrachintāmaṇi," "Rasendrasārasamgraha" and other treatises, this preparation is described as "Makaradvaj" and "Rasasindūra" (lit. minium-like mercury). From the supposed presence of gold it is often named "Svarnasindūra" (lit. gold and vermillion). During sublimation, the gold of course is left behind. The general belief is that by association with gold the mercury acquires most potent efficacy. A later work, Rasapradīpa, is sceptical about the part which gold plays and recommends its being left out.

(2) Sārngadhara also gives a similar recipe.

a covered crucible after addition of fresh quantities of the above paste. The mercury is reduced to ashes, resembling salt. 112-113

The seeds of *achyranthes aspera* and *ricinus communis* are to be pounded together. The mercury is to be placed inside the powder and the mass roasted as before. The mercury is reduced to ashes.¹ 114

Purified mercury is to be preserved in the hollow of a horn or tooth or of bamboo. 119

* * * *

Here ends chapter XI of "Rasaratnasamuchchaya," which treats of the purification fixation and incineration of mercury.

Notes on the Minerals

Diamond: Belief in the combustibility, of diamond (*vide pp.101-2*) was an accepted creed with

(1) Cf. *Rasendrachintámani*, which evidently quotes from a Tántric work: "O Goddess, I shall now enumerate the substances which kill mercury, without the use of sulphur." A list of 41 plants is given of which any ten may be employed at a time for the roasting operation. The names of the following among others occur in the list: *vitis quadrangularis*, *andropogon serratus*, *plumbago seyanica*, *clitorea ternatea*, milky juice of *calotropis gigantea* and of *euphorbia neriifolia*; *vitex negundo*, *datura stramonium*, *achyranthes aspera*, *ficus oppositifolia* and *tinospora cordifolia*

the Hindu Iatro-Chemists. The reader will find much useful information in the following extract.

'This combustibility of the diamond appears to have been observed at an early period, although the fact does not seem to have attracted the general attention of the older chemists, as statements of a contrary character are recorded by them. Thus, for instance, Kunkel states that his father, at the command of Duke Frederick of Holstein, heated diamonds in his gold-melting furnace, for nearly thirty weeks, without their undergoing any change. It is to Newton, however, that we owe the first argument which went to prove that the diamond was capable of undergoing combustion on account of its high refractive power, a property characteristic of the class of oily bodies. In the second book of his *Opticks*, Newton says upon the subject, "Again the refraction of camphire, oyl-olive, lint-seed oyl, spirit of turpentine and amber, which are fat sulphureous unctuous bodies, and a diamond, which probably is an unctuous substance coagulated, have their refractive powers in proportion to one another as their densities without any considerable variation." The conclusion to which Newton was led by theoretical considerations was experimentally proved to be correct in the year 1694-5 by Averami

and Targioni, members of the Academia del Cimento, who, at the request of the Grand Duke Cosmo III., of Tuscany, placed a diamond in the focus of a large burning-glass and observed that it entirely disappeared. Francis I., who is said to have received from an alchemist an anonymous receipt for melting diamonds, exposed, in the year 1751, diamonds and rubies of the value of 6,000 gulden for twenty-four hours to the action of a powerful fire; the rubies were found unaltered, but the diamonds had altogether disappeared. The volatilization of the diamond by means of heat was from this time forward made the subject of numerous experiments. Thus, Darcet observed in 1766 that diamonds disappear when they are heated in a cupel-furnace, even in closed crucibles, but, continuing his experiments at the request of the Paris Academy, he, together with Rouelle, found that when heated in perfectly hermetically-sealed vessels, the diamond did not disappear. Macquer, in the year 1771, was the first to observe that when the diamond undergoes volatilization it appears to be surrounded by a flame. In conjunction with Cadet and Lavoisier, he afterwards found that a true combustion takes place. In continuation of these experiments Lavoisier, together with Macquer, Cadet,

Brisson, and Baumé,¹ placed a diamond in a glass vessel containing air collected over mercury, and on igniting the diamond by means of a burning-glass, they found that carbonic acid gas was produced."—Roscoe and Schor. Vol i. pp. 658-59.

Mr. T. H. Holland, F.G.S., A.R.S.M., of the Geological Survey of India, to whom was submitted the translation of the descriptions of the minerals (*vide* pp. 79-100), has favoured me with his opinion, which is reproduced below in his own words. It will, to a certain extent, help in the identification of the minerals.

"I have appended notes giving suggestions which may help to explain some of the passages, but the majority of descriptions are altogether too vague to permit identification of the minerals. The names of minerals already given are presumably recognised translations; for the descriptions accompanying the names might just as well, in many instances, apply to several minerals known in this country.

"Vaikranta has 8 faces and 6 angles" &c., (p. 83) possibly refers to a mineral crystallizing in the octahedral form, and of the many minerals crystallizing in this form the family of spinels is

(1) Lavoisier : *Oeuvres*, tome ii. 38, 64.

more likely to exhibit the great range of colours given.

“White”—Unknown.

“Red”—Ruby spinel.

“Yellow”—Rubicelle (orange to yellow) : dysluite (yellowish brown).

“Blue”—Almandine (violet).

“Grass-green”—chlorospinel, hercynite (black when massive, green by transmitted light and in powder), pleonaste (dark-green) ;

“black”—magnetite, gahnite, franklinite &c. ;

“variegated”—some magnesia spinels ;

“8 Faces and 6 angels” might possibly also refer to the hexagonal prism with basal planes, a common form of corundum, which gives the variety of colours referred to even more perfectly than the spinels.

But the remarks on p. 104 as to the “liquefaction” of this mineral, cannot apply to either spinel or corundum. Unless there is some failure to appreciate the original meaning the statements are nonsensical.

Mākshikam (pyrites) Pyrites is of two kinds—golden and silvery; the former is a native of Kanauj, and is of golden yellow colour. The silvery pyrites is associated with stones and

is of inferior quality."

Mākshika repeatedly steeped in [organic substances] and gently roasted in a crucible yields an essence of the appearance [in the shape] of copper' (p. 84.)

Iron pyrites [Fe S_2] is brass-yellow in colour, and its dimorphous form marcasite is pale bronze-yellow; but there are other pyrite-like minerals which are silvery white; for instance, cobaltite (Co S_2 , Co. As_2), smaltite (Co As_2), löllingite (Fe As_2 with S) and leucopyrite ($\text{Fe}_3 \text{As}_4$). Iron pyrites roasted in air would give a red residue of $\text{Fe}_2 \text{O}_3$. But it seems more likely that the "golden-yellow" variety is copper-pyrite, which has a deep yellow colour and besides which iron-pyrite when freshly fractured would appear almost silvery in colour. In that case the "essence of the appearance of copper" might be the metal itself.¹

"Sasyaka (blue vitriol) has the play of colours in the throat of the peacock." (p. 86.)

The experiments referred to might apply to any copper compound. There is a copper ore, bornite or erubescite ($\text{Cu}_3 \text{Fe S}_4$), which, on account of its

(1) Vimala (pp. 84-85) would appear also to be a variety of pyrites.

peculiar colour and iridescence, is known as "peacock" ore. It occurs in several parts of India.

Gairika: hematite, which is red and often hard, and limonite which is yellow or brown, both occur in the form of ochres.

'*Kamkushtham* is produced at the foot of the Himalayas . . . it is of white and yellow colour and is a strong purgative."

Possibly an efflorescence of magnesium sulphate or sodium sulphate ; both are not uncommon. The yellow colour might be due to admixture with ferruginous dirt due to oxidation of the ferrous sulphate produced by similar causes with the other sulphates.

Vajram: the remarks "8 faces and 6 corners" would be correct for an octahedral crystal of diamond ; but I know of no crystal form which has at the same time "8 angles." The faces of the diamond are frequently rounded, which may account for the statements about the "female" and "neuter" diamonds. Many transparent minerals give a play of colours through either schillerization or refraction ; but the diamond is of course particularly noticeable on account of its high dispersive power."

The following extracts from Ball's "Economic Geology of India" will also throw considerable

light on this subject. It will be seen how in India the traditions of the technical arts of which we get vivid glimpses in the *Rasārṇava* have been preserved even to our own days from time immemorial.

“Rājputanā—Copper ores are found in several of the independent States of Rājputanā, and also in the British district of Ajmīr. Mining has been practised on a large scale, but at present the trade of miner is becoming extinct and the operations, which are only carried on in a few of the localities are of a very petty nature.

“The names of the States in which there are mines are as follows: Alwar, Bhartpur, Jaipur, Udepur, Bundi and Bikanir.

“Alwar State.—According to Mr. Hacket there are ancient copper mines at the following localities in this state: Daribo, Indawas, Bhangarh, Kusalgargh, Beghani, Pratabgarh, Tassing, and Jasingpura. The most important of this is the first.

“Deribo.—The mine is situated on a sharp anticlinal bend in a thin band of black slates intercalated in the Alwar quartzites. There appears to be no true lode; the one, which is pyrites mixed with arsenical iron, occurs irregularly disseminated through the black slates, a few specks and stains only being seen in the quartzites; occasionally rich

nests of ore were met with From an interesting account by Major Cadell, the following facts regarding the manufacture have been extracted. The ore, as usual in the native process, is pounded, made up into balls with cow-dung, roasted, and then smelted in a closed furnace and refined in an open charcoal fire. Thirty pounds of ore require four times that quantity of charcoal and yield $5\frac{1}{2}$ pounds of metal, or 16.6 per cent. During the last 12 years the average annual outturn has been only 3 tons 8 cwts., and it is diminishing owing to the influx of European copper.

" Singhana (Jaipore State).—The copper mines at Singhana are situated in rocks belonging to the Arvali series. The earliest account of these mines, which is believed to have been by Captain Boilcan, was published in the year 1831. The principal productions were copper, blue vitriol or copper sulphate, alum, and an ore of cobalt called *sehta* or *saita*.

" The mines are described as being tortuous and of great extent; at the working faces it was the custom to light fires which caused the rock to split up. Lamps were used which the miners carried on their heads and with a gad and hammer extracted the ore. The principal ore found appears

to have been pyrites. It was sold retail by auction to the proprietors of different furnaces.

"The pounding or crushing was effected on a stone anvil with a hammer weighing eight or ten seers; when completely reduced to powder the ore was made up into balls with cow-dung and roasted. The blast furnaces (*vide illustrations*) were prepared in the following manner. A quantity of common sand was spread on the door of a circular hut, in the centre of which a depression, 12 to 15 inches in diameter and 2 or 3 inches deep, was made; in this a layer of fine sand and another of ashes were laid to prevent the metal from adhering to the bottom of the receiver; two clay nozzles or tuyères were then placed on opposite sides of this hollow and a third between them, leaving the fourth side vacant for the slag to escape. The nozzles were then connected by moist clay and a circular rim of mud, a few inches in height, was raised, on which three annular vessels of fire-clay were placed to form the body of the furnace, each of these was 15 inches in external diameter, 10 inches high, and 3 inches thick. They were used repeatedly, but the lower part of the furnace had to be reconstructed for every charge. The bellows were simply goat-skins connected with the nozzles,

and were worked by the families of the smelters. After a preliminary firing, to dry the mud, the furnace was charged with charcoal, roasted ore and iron slag, the latter being employed as a flux.

"In a day of nine or ten hours' duration, 3 maunds of charcoal, $2\frac{1}{2}$ of the roasted ore, and 2 of the iron slag were consumed. The slag was drawn off and the smelted copper which had accumulated at the bottom of the furnace was removed on the following day. It was then re-melted and refined in an open furnace under a strong blast from bellows, and cast into small bars or ingots, which were subsequently removed to the Mint and cut up and fashioned into coins.

"The ore was said to yield only from to $2\frac{1}{2}$ to $7\frac{1}{2}$ per cent. of metal, but the profits must have been not inconsiderable as the Khetri Rājā is said to have claimed one-sixth of the value of the copper in addition to Rs. 14,000 received for the lease. The quality of the metal is said to have been inferior to that of Basawar, this being attributed to the use of the iron slag as a flux

. . . Considerable quantities of blue vitriol (copper sulphate), alum, and copperas (iron sulphate) are manufactured from the descomposed slate and refuse of the mines. The slates are

steeped in water, which is afterwards evaporated in large iron vessels, when the blue vitriol, is crystallized out, afterwards the alum, and lastly the copperas. Mr. Mallet found traces of nickel and cobalt in all three of these substances.

"Copper smelting in the Singhbhum District (Bengal).—Indications exist of mining and smelting having been carried on in this region from a very early period, and the evidence available, points to the Seraks or lay Jains as being the persons who, perhaps 2,000 years ago, initiated the mining.¹ The number and extent of the ancient workings testify to the assiduity with which every sign of the presence of ore was exploited by these early pioneers and those who follow them up to recent times."

The Treatise on Alchemy attributed to Bubacar (10th to 11th century A. D.) also contains many similar descriptions of the gems and minerals; specially noticeable is the classification according to sex—*male* and *female* (cf. Bk. IV, 27-28, p. 100). We append below one or two short extracts.

"Viennent ensuite les treize genres de pierres, savoir: les marcassites, les magnésies, les tuties,

(1) Proc. As. Soc. Bengal, June 1869, p. 170.

l'azur (lapis lazuli ou cinabre ?), l'hématite, le gypse, etc., et toute une suite de minéraux désignés sous des noms arabes. Parmi les marcassites (sulfures), on distingue la blanche, pareille à l'argent ; la rouge ou cuivrée ; la noire, couleur de fer ; la dorée, etc.

“Les magnésies¹ sont aussi de différente couleur, l'une noire, dont la cassure est cristalline,² une autre ferrugineuse, etc. Une variété est dite mâle ; une autre, avec des yeux brillants, est appelée femelle ; c'est la meilleure de toutes.

“Les tuties³ sont de différentes couleurs : verte, jaune, blanche, etc.”

“La classe des vitriols (*atramenta*) comprend six espèces : celui qui sert à faire du noir, le blanc, le calcantum, le calcande, le calcathar, et le surianum. Il y en a un jaune, employé par les orfèvres ; un vert mêlé de terre, employé par les mégissiers, etc.”—“La Chimie au moyen âge,” T. I., 307.

(1) Ce mot désignait certains sulfures et oxydes métalliques, tels que les oxydes de fer magnétique, le bioxyde de manganèse, etc.

(2) Offre dès yeux brillants.

(3) Oxydes et minerais de zinc, renfermant du cuivre.

ALUM AND GREEN VITRIOL

Dutt speaking of alum states: "it is not mentioned by Susruta, in his list of metallics, but later writers give its synonyms and uses." This is evidently incorrect. Alum, with green vitriol, is distinctly referred to in the Susruta, *e. g.*:

काशोसं चिहतादन्ते हरितालं सुराष्ट्रजा ।

Sūtra. xxxvi, 12.

In the above sloka *surāshtrajā*, lit., begot of Surāshtra (modern Surat), is used in the sense of alum. From the ancient times the "earth of Surat" has been known to yield this mineral. Amara Simha in his Lexicon, written sometime between 400-600 A. D.,¹ gives among others the following synonyms of alum:—*kāmkshī*, *tuvarī* and *surāshtrajā*. "Rasaratnasamuchchya" also gives the same synonyms. (Bk. III., 59-62). The manufacture of alum survives to our own days, as the following description will show:

"Alum shales, so called, are of rare occurrence in peninsular India, and, so far as it known, the

(1) The lowermost limit of his age may be taken about 948 A. D. as made out from an inscription in Budh Gaya.

only considerable native manufacture is situated in Rājputana; but as will be gathered from what follows, the tertiary rocks of the extra-peninsular regions often contain such shales.

" In two localities lumps of alum...occur naturally in sufficient abundance to be a regular article of export.

" Alum is principally used as a mordant in dyeing, but as a drug its employment is extensive in India.

" BEHAR.—Captain Sherwill in 1846¹ stated that a small quantity of alum was manufactured from slates obtained in the district of Shahabad; these rocks, it is believed, belonged to the Bijigrah pyritous shales of the Kaimur group of the Vindhyan series.

" The alum was sold at the high price of one rupee per *tola*; it was identical with the *salajit* of Nepal. Copperas or iron sulphate is obtained in the same region, which is situated to the north of Rotasgarh, and to the west of the Sone.

" Rājputana, Khetri, and Singhana.—In connection with the copper mines at the above localities

(1) Journ. As. Soc. XV., p. 58.

there are manufactories which turn out considerable quantities of blue vitriol (copper sulphate), copperas (iron sulphate), and alum. The process has been very fully described and illustrated by Colonel Brooke. In 1864 there were twenty of these factories at Khetri and about double the number at Singhana. The broken shale from the mine which contains the salts is placed in earthen *gharas*, together with the crusts from the refuse heaps of previous lixiviations and water is added. The *gharas* are arranged on ledges prepared for the purpose on the heaps of refuse, as will be seen by reference to the wood-cut (*vide illustrations*).

"Each charge of shale is exposed to three changes of water and the water itself is changed from one *ghara* to another till it has taken up the sulphates from seven different steepings. It is then of a thick dirty-bluish colour and is taken to the boiling house, where it is boiled in earthen *gharas*; when sufficiently concentrated it is left to cool, and thin sticks being introduced the blue vitriol crystallizes on them. The mother liquor is then poured off and again boiled, and on the addition of saltpetre, the alum crystallizes at the bottom of the vessel. The residual sulphates still in solution, are allowed to crystallize out by ex-

posing the mixture to the sun.

* * * *

“CUTCH.—There are numerous accounts of the manufacture of alum in Cutch. The earliest is by Captain Mc Murdo, who states that before 1818 the exports of alum amounted in some years to several hundred thousand maunds, which chiefly went to Guzerat and Bombay to be employed in dyeing. The following account by Mr. Wynne is the most recent and complete. The site of the operations is at Mhurr or Madh.

“The rock containing the materials is a pyritous dark-gray or black shale, which is in close association with a soft aluminous pseudo-breccia of the sub-nummulitic group.

“This shale is excavated from pits and is exposed for four months, a slow combustion taking place owing to the decomposition of the pyrites.

“It is then spread in squares resembling salt pans and sprinkled with water. After about 12 days it consolidates into efflorescing mammillated crystalline plates or crusts called *phitkari-ka-bij* or seed of alum. These crusts are boiled in large iron vessels (luted inside with lime), together with saltpetre (or other potash salt), in the proportion of 15 of ‘alum seed’ to 6 of the latter; when it has

settled, the liquor is placed in small earthen vessels somewhat the shape of flower-pots, and crystallization takes place in three days. These crystals are again boiled one or more times to concentrate the solution, which is finally ladled into large thin bladder-shaped earthen *mutkās* or *gharās* with small mouth ; these are sunk into the ground to prevent their breaking, and in five days the alum is found crystallized in masses. The vessels are then broken and the alum is stored.

"Alum is also manufactured from the water of a hot spring north of Mhurr. The impure salt-petre, which is employed to supply the second base in the above-mentioned manner, is obtained by lixiviation of village refuse." (Ball's "Economic Geology", pp. 431-33).

"IRON SULPHATE.—The green vitriol or copperas of commerce, which is known to the natives as *kahi* and *hara kāsis*, is produced principally from the so-called alum shales from which alum is prepared. As is the case also with alum, copperas is found sometimes as a natural exudation upon alum shales and other rocks which include iron pyrites.

"This native copperas goes by several different names in India, according to the nature of the other substances with which it is combined.

"BEHAR.—In the year 1833, Mr. J. Stevenson published an analysis of native sulphate of iron obtained from Behar, which was at that time used by the native dyers of Patna.

He found that it consisted of—

Iron sulphate	39.0
„ peroxide	36.0
Magnesia	23.0
Loss	2.0

ibid p. 419.

100.0

tempering of steel. The blades of Damascus were held in high esteem but it was from India that the Persians and, through them, the Arabs learnt the secret of the operation.¹

The wrought-iron pillar close to the Kutub near Delhi which weighs ten tons and is some 1500 years old ; the huge iron girders at Puri ; the ornamental gates of Somnath and the 24-ft wrought-iron gun at Nurvar—are monuments of a bye-gone art and bear silent but eloquent testimony to the marvellous metallurgical skill attained by the Hindus. Regarding the Kutab pillar, Fergusson says : "It has not, however, been yet correctly ascertained what its age really is. There is an inscription upon it, but without a date. From the form of its alphabet, Prinsep ascribed it to the 3rd or 4th century ; Bhau Daji, on the same evidence, to the end of the 5th or beginning of the 6th century. The truth probably lies between the two. Our own conviction is that it belongs to one of the Chandra Rajas of the Gupta dynasty, either subsequently to A. D. 363 or A. D. 400.

(1) *Vide Trempe du Fer Indien* : "Elle a été découverte par les Indiens et exposée par les Perses, et c'est de ceux-ci qu'elle nous est venue."—Berthelot : "Coll. Alch Grec." T. 3, *trad.* p. 332.

"Taking A. D. 400 as a mean date—and it certainly is not far from the truth—it opens our eye to an unsuspected state of affairs to find the Hindus at that age capable of forging a bar of iron larger than any that have been forged even in Europe up to a very late date, and not frequently even now. As we find them, however, a few centuries afterwards using bars as long as this *lat* in roofing the porch of the temple at Kanaruc, we must now believe that they were much more familiar with the use of this metal than they afterwards became. It is almost equally startling to find that after an exposure to wind and rain for fourteen centuries, it is unrusted, and the capital and inscription are as clear and as sharp now as when put up fourteen centuries ago.

"There is no mistake about the pillar being of pure iron. Gen. Cunningham had a bit of it analysed in India by Dr. Murray, and another portion was analysed in the School of Mines here by Dr. Percy. Both found it pure malleable iron without any alloy." "Hist. of Indian and Eastern Architecture," p. 508 ; ed 1899.

The Ritter Cecil von Schwarz, who was for sometime in charge of the Bengal Iron Works Company, thus speaks of the superior iron smelting

industry in India :—

"It is well-known by every manufacturer of crucible cast-steel how difficult it is sometimes to get the exact degree of hardness to suit certain purposes, especially with reference to steel for cutting the blades, etc., With the ordinary process, endeavours are made to reach the required degree of hardness by selecting such raw materials as on an average have the required contents of carbon in order to correspond with the required degree of hardness as far as possible. The natives [of India] reached this degree by introducing into their cast-steel an excess of carbon, by taking this excess gradually away afterwards, by means of the slow tempering process, having it thus completely in their power to attain the extact degree by interrupting this de-carbonsing process exactly at the proper time in order to cast steel of a quality exactly suitable for the purpose."

ZINC

The extraction of zinc from the ores can be followed in every detail from the account left us both in "Rasārnava" and "Rasaratnasamuchchaya."

"Rasaka" is mentioned in *Rasārnava* as the mineral which turns copper into gold (p. 71). We have also in the succeeding couplets a process described for the reduction of the ore. This process is so elaborately given in R. R. S. that it may be quoted almost *verbatim* in any treatise on modern chemistry ; it is practically the same as distillation *per descensum*—the flame of bluish tint issuing from the mouth of the crucible indicates the combustion of carbon monoxide, so often observed in metallurgical operations.¹ (See p. 88).

From the time of the *Susruta* to that of R. R. S., we find all along six metals recognised (see pp. 48 and 127) and the last work distinctly mentions brass and bell-metal as simply alloys. Owing to the veneration paid to ancient authorities, the Indian alchemists had at first some hesitation in classing "the essence of the lustre of tin" "ताम्रम्" (p. 71) as a separate metal. In the medical Lexicon ascribed to king *Madanapāla* and written about the year

(1) Cf. "A mixture of 2 parts of ground roasted ore and 1 part of coal dust is brought into the retorts, each holding about 40 lbs. of the mixture. As soon as the temperature has risen high enough, the reduction begins and *carbon monoxide is evolved and burns* from the end of the clay adapter *with a blue flame* (the italics, are ours). Roscoe and Schorlemmer's Chemistry, Vol. II., Pt. I p. 255, ed. 1879.

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1374 A. D.,¹ zinc is, however, distinctly recognised as a metal under the designation of *Jasada*.²

It is evident rasaka is the *cadmia* of Dioscorides and Pliny and tutia of the alchemists of the middle ages. The pseudo-Basil Valentine writing about 1600 A. D. uses the word zinc but "he does not appear to have classed it with the metals proper." Paracelsus mentions zinc sometimes as a metal and sometimes as a *bastard* or *semi-metal*, but it is doubtful whether he had any distinct notion of its true character specially as he says, "it has no malleability" (keine malleabilität hat er) or of the ore which yielded it.³ "Libavius was the first to investigate the properties of zinc more exactly, although he was not aware that the metal was derived from the ore known as *calamine*. He states that a peculiar kind of tin is found in the East Indies called Calaëm. Some of this was brought to Holland and came into his hands." (Roscoe and Schorlemmer).

The terms rasaka, kharpura, kharpara-tuttha

(1) Roth : "Indischen Studien," XIV, 399; also Bühler : Intro. to Manu, CXXV.

(2) जसद रङ्गसङ्घर्षं इति हेतुष्य तन्मातम् ।

(3) "Gesch. d. Chemie," IV, 116.

and tuttha are all applied to calamine, while tuttha sometimes stands for blue vitriol as well. Some writers have, however, mistaken kharpara for blue vitriol, but R. R. S. is very explicit on this point. The name *tutenague* by which Chinese zinc was known in commerce is evidently derived from the Tamil *tatanagam*. "In Persian, sulphate of zinc is called *suffed* (white) *tutia*; sulphate of copper, *neela* (blue) *tutia*; and sulphate of iron, *hura* (green) *tutia*; so, in Avicenna, different kinds are described under this name, which occurs also in Geber" (Royle). Both the Tamil *tatanagam* and the Persian *tutia* are probably corruptions of the Sanskrit word *tuttham*. At the beginning of the last century the Baron de Sacy was at considerable pains in tracing the history of *tutia*. In a note appended to certain extracts from Kazwini, the "oriental Pliny," the learned Frenchman gives the following description of *tutia*. The account necessarily involves some digressions on the Aristotelian theory of the formation of dew, hail-stone, metals, &c., and the reader may with advantage compare it with that of the Vaisesika Philosophy. (Chap. I, pp. 1-12).

"Le *khar-sini* est aussi nommé *fer de la Chine* . . . et *or cru* . . . Je crois que ce même

métal est aussi désigné sous les noms de *djosd* ou *djost* dans l'Inde, de *tutie fossile* . . . chez les Arabes, enfin *d'esprit de tutie* . . . dans l'*Ayin Acbéri*, et que c'est la *toutenague*, dont il y a plusieurs variétés plus ou moins analogues au zinc.

“ Je vais rapporter, pour mettre le lecteur à portée de juger de ma conjecture, ce que je trouve dans le Dictionnaire des médicaments simples par Ebn-Beïtar, sur les diverses espèces de tutie fossile, et un article curieux de l'*Ayin Acbéri*, omis pour la trèsgrande partie dans la traduction angloise de M. Gladwin ; j'en donnerai le texte d'après deux manuscrits de cet ouvrage, dont l'un m'appartient, et l'autre faisoit autrefois partie de la bibliothèque de feu M. Langlès et d'après le Traité de médecine, dédié au prince Dara-schékouh, où il se trouve tout entier (manuscrit de M. Brueix, acquis par la bibliothèque du Roi, n.^o 16, fol. 62 et suiv.) Je joindrai à cela ce que dit Kazwini de la formation du *khar-sini* et de ses usages médicaux et économiques, laissant aux minéralogistes à juger si, dans ces descriptions mêlées d'hypothèses arbitraires, et de quelques traits suspects de charlatanisme, on peut reconnoître la toutenague.

“ Voici d'abord le passage d'Ebn-Beïtar.

"Edu-Wafid dit : il y a deux espèces de tuties ; l'une se trouve dans les mines, l'autre dans les fourneaux où l'on fond le cuivre, comme la *cadmie* ; cette dernière espèce est ce que les Grecs nomment *pompholyx*. Quant à la tutie fossile, il y en a trois variétés ; l'une blanche, l'autre verdâtre, la dernière d'un jaune fortement rougeâtre. Les mines de celle-ci sont dans les contrées maritimes de la mer de Hind et de Sind : la meilleure est celle qui semble au coup-d'œil couverte de sel ; après celle-ci, la june ; quant à la blanche, elle a quelque chose de graveleux : et est percée : on l'apporte de la Chine. La tutie blanche est la plus fine de toutes les variétés et la verte, la plus grossière ; quant à la tutie des fourneaux, Dioscoride dit, livre V.e. : *Le pompholyx, qui est la tutie, diffère du spodion &c.*"

"L' *Ayin Acbéri* expose la formation des minéraux et celle des métaux en particulier, suivant une hypothèse, commune, je crois, à tous les alchimistes anciens ; et quoique ces détails méritent par eux-mêmes peu d'attention, je rapporterai le passage en entier, 1.^o parce que M. Gladwin l'a omis ; 2.^o parce qu'il est nécessaire pour que l'on puisse juger de la nature du *khar-sini* et de l'identité que je suppose entre cette

substance métallique et l'*esprit de tutie*. Il y a dans le texte de l'*Ayin Acbéri* quelques omissions que je rétablirai d'après le Traité dédié à Dara-schéko'ih, où ce chapitre se trouve tout entier, et il n'est pas le seul qui soit commun à ces deux ouvrages. L'auteur de ce dernier traité, , annonce lui-même, fol. 62, *verso*, qu'il va tirer quelques chapitres sur les métaux, de l'ouvrage de feu Abou'l Fazel, formant le III.e tome de l'*Acber-namèh* : l'un de ces textes me servira à corriger l'autre.

De la formation des métaux.

"Le dieu créateur de l'univers a donné l'existence à quatre élémens en opposition les uns aux autres, et il a suscité quatre êtres d'une nature admirable : le feu chaud et sec, qui possède une légèreté absolue ; l'air chaud et humide, doué d'une légèreté relative ; l'eau froide et homide, qui possède une pesanteur relative, la terre froide et sèche, douée d'une pesanteur absolue. La chaleur produit la légèreté, et le froid la pesanteur ; l'humidité facilite la séparation des parties, la sécheresse y met obstacle. Par la combinaison de ces quatre puissances élémentaries, ont été produits tous les êtres dont l'existence est due

l'influence des corps célestes, les minéraux, les végétaux et les animaux.

“ Les particules aqueuses, ayant acquis par les rayons du soleil et autres causes un plus grand degré de légèreté, se mêlent avec les particules aériennes, et s'élèvent en l'air : c'est cette combinaison que l'on nomme *vapeurs*. Par le moyen de cette combinaison, les molécules terreuses étant mêlées elles-mêmes avec les particules aériennes, s'élèvent aussi en l'air ; et c'est ce qu'on nomme *exhalaisons* : quelquefois aussi les particules aériennes se mêlent [immédiatement] avec les molécules terreuses. Il y a des philosophes qui appliquent également le nom de *vapeurs* à ces deux sortes de combinaisons élémentaires : ils désignent celles qui sont le produit des particules aqueuses, par le nom de *vapeures humides* ou *aqueuses* ; et celles qui doivent leur formation aux molécules terreuses, par le nom de *vapeurs sèches* ou *fuligineuses*. Ce sont ces deux sortes de vapeurs qui forment au-dessus de la terre les nuées, le vent la pluie la neige et autres phénomènes semblables ; et dans l'intérieur du globe, les tremblemens de terre les sources et les mines. On regarde les vapeurs comme le corps, et les exhalaisons comme l'esprit : des unes et des autres, suivant la diversité de leurs

combinaisons et les différentes proportions dans lesquelles elles s'unissent, sont produites dans le laboratoire de la nature un grand nombre de substances diverses. Suivant ce qu'on lit dans les traités de philosophie, on ne compte pas plus de cinq espèces de minéraux : ceux qui sont infusibles à cause de leur sécheresse, comme le *yakout* ; ceux qui le sont à cause de leur humidité, comme le vifargent ; ceux qui se fondent promptement, mais qui ne sont ni malléable, ni combustibles, comme le vitriol ; ceux qui ne sont pas malléables, mais qui sont combustibles, comme le soufre ; ceux enfin qui sont malléables, mais inccombustibles comme l'or. La fusion d'un corps consiste dans la liquéfaction de ses parties, due à la combinaison de la sécheresse et de l'humidité : la malléabilité [ou ductilité] est la faculté qu'a un corps de recevoir peu à peu une augmentation d'étendue, tant en longueur qu'en largeur, sans séparation d'aucune de ses parties et sans aucune addition.

“Quand les vapeurs et les exhalaisons se mêlent de manière que les premières soient le principe dominant, et que le mélange étant achevé et la coction parfaite, l'ardeur du soleil coagule cet amalgame, le produit est du vif-argent. Comme il n'y a aucune des molécules de ce produit qui ne ren-

ferme quelque portion d'exhalaison, ce corps a une qualité sèche dont les effets sont sensibles : il ne s'attache pas à la main ; au contraire, il fuit le contact : comme la chaleur a été le principe de sa coagulation, la chaleur ne peut la détruire. Si les deux principes [les vapeurs et les exhalaisons] se combinent dans des proportions à-peu-près égales, il se manifeste dans le mélange une humidité d'une nature visqueuse et onctueuse : à l'instant de la fermentation des particules aériennes s'insinuant dans le mélange qui se coagule alors par le froid, les produits de cet amalgame sont inflammables. Si les exhalaisons et la qualité onctueuse dominent, le produit est du soufre, qui est rouge, jaune, bleu ou blanc ; s'il y a plus d'exhalaisons et peu de principe onctueux, l'amalgame donne l'arsenic qui est rouge et jaune ; enfin si ce sont les vapeurs qui dominent, il se trouve, quand la coagulation est achevée, que le produit est de la naphte qui est noire et blanche. Comme, dans ces amalgames, la coagulation est produite par le froid, ces corps sont fusibles par la chaleur : et à cause de l'abondance de leur qualité huileuse et de leur humidité visqueuse, ils sont susceptibles de prendre feu ; enfin, à raison de leur excès d'humidité, ils ne sont point malléables. Les sept corps [ou metaux] ayant

tous pour principes constituans le vif-argent et le soufre, la variété de ces corps ne peut avoir pour cause que les divers degrés de pureté de ces deux principes, la plus ou moins grande perfection de leur mélange, et la diversité d'influence qu'ils exercent l'un sur l'autre.

"Si les deux principes ne sont altérés par aucun mélange de parties terreuses, s'ils sont dans toute leur pureté naturelle, si enfin ils éprouvent une coction parfaite, alors le soufre étant blanc et le vif-argent dans une proportion plus grande, le produit de l'amalgame est de l'argent ; il est de l'or, si les deux principes sont dans des proportions égales, et que le soufre soit rouge et possède la force colorante. Si, les circonstances étant les mêmes, après le mélange mais avant la parfaite coction, l'amalgame est coagulé par le froid, il se forme du *khar-tchini*, que l'on nomme aussi *fer de la Chine*, ce qui équivaut pour le sens à de l'*or cru* : quelques-uns le regardent comme une sorte de cuivre." (La même doctrine sur la formation du *khar-tchini* ou *âhen-tchini*, nommé encore *or cru*, se trouve dans cet ouvrage, fol. 60 *recto*, lig. I re et suiv). "Si le soufre seul n'est pas pur, que le vif-argent domine, et que la force brûlante unisse les deux principes, le produit est du cuivre. Quand

le mélange n'est pas fait convenablement, et que la proportion du vif-argent est la plus forte, il se forme de l'étain : quelques-uns prétendent que l'étain ne se forme pas à moins que les deux principes ne soient l'un et l'autre dans un état de pureté. Si les deux principes sont mauvais et très-altérés, qu'il y ait dans le vif-argent des molécules terreuses interposées, et dans le soufre une qualité brûlante, il résulte, de l'amalgame, du fer : enfin le produit est du plomb, si, les circonstances étant d'ailleurs les mêmes, le mélange ne se fait pas complètement, et que le vif-argent domine. On donne à ces sept substances le nom de *corps* ; on appelle le vif-argent *la mère des corps*, et le soufre *leur père* : on considère aussi le vif-argent comme *l'esprit*, et l'arsenic ainsi que le soufre, comme *l'âme*. Le *djost*, suivant quelques personnes, est *l'esprit de tutie*, et approche du plomb : il n'en est fait aucune mention dans les livres de philosophie. Il y en a une mine dans l'Indoustan, dans le territoire de Djalour, qui fait partie du soubah d'Adjmir.

" Les alchimistes disent que l'étain est un argent malade de la lèpre, le mercure un argent frappé de paralysie, le plomb un or lépreux et brûlé, et le cuivre un or cru, et que l'alchimiste, semblable à un médecin, remédié à ces maux par des

moyens contraires ou assimilés.

"Les savans qui s'adonnent à la pratique des arts, font, avec ces sept corps, des compositions artificielles dont on se sert pour fabriquer des bijoux, joyaux, &c. Du nombre de ces compositions est le *séfid-rou* [c'est-à-dire, *blanc à l'extérieur*, peut-être le *pé-tong* des Chinois], nommé *cansi*¹ par les Indiens, qui se compose de quatre sères de cuivre et d'un sère d'étain unis par la fusion : le *rouï*, composé de quatre sères de cuivre et d'un sère et demi de plomb, et que l'on appelle dans l'Inde *bahngar* : le *biroundj*, nommé par les Indiens *petel*² et dont il y a trois variétés : la première, qui se bat à froid, et contient deux sères et demi de cuivre, et un sère d'esprit de tutie ; la seconde, qui se bat à chaud, composée de deux sères de cuivre et d'un sère et demi d'esprit de tutie ; la troisième, qui ne se bat point, mais qui s'emploie pour les ouvrages jetés en moule et dans laquelle il entre deux sères de cuivre, et un sère d'esprit de tutie : le *sim-sakhtèh* [*argent marqué* ou *pesé* ; peut-être faut-il lire *soukhtèh*, *brûlé*]," dans la

(1) Kámsya, See p. 114.

(2) Pittala, See p. 114.

composition duquel il entre de l'argent, du plomb et du cuivre, dont la couleur est d'un noir éclatant, et qui s'emploie dans la peinture : le *heft-djousch* [*bouilli sept fois*], dans lequel on se contente d'amalgamer six métaux, lorsqu'on n'a pas de *khar-tchini*; quelques-uns lui donnent le nom de *talikoun* [catholicon]; mais suivant d'autres, le talikoun est un cuivre préparé : l'*escht-dhat*, composé de huit choses, savoir, les six métaux susdits, l'esprit de tutie et le *cansi*; on le fait aussi avec sept substances seulement : le *caulpatr* composé de deux sères de *séfid-rou*, et d'un sère de cuivre : il prend une couleur foncée très-agréable. C'est une des inventions de notre saint empereur.”¹

On the Essence of Minerals CALAMINE

It will be seen Gladwin's rendering of *A'in-i-Akbari* is not very reliable; it may, however, be noted here that even Blochmann in his much improved and more accurate translation erroneously

(1) “Chrestomathie Arabe,” T. III. pp. 453-58 ed. 1827.

renders *jost* as "pewter."¹ The *rúh i tútia* (spirits of tutia) is used in the above extract in the same sense as in *Rasārnava*, which describes zinc as the *svattam* (essence) of *rasaka* (see p. 71). In R. R. S. also we find that blue vitriol yields a "*svattam*," which is no other than copper"² (p. 86).

THE VITRIOLS

From the writings of Dioscorides and Pliny it does not appear that the ancient Greeks and Romans drew any sharp distinction between blue

(1) Vol. I p. 40.

(2) The "essence or spirits of minerals" is used here in a different sense from that of the generality of the Arabian and European alchemists. According to the latter there are four spirits of minerals, namely, sulphur, arsenic, sal-ammoniac and mercury. "Les mots *esprits*, *corps*, *âmes*, sont fréquemment employés par les alchimistes dans un sens spécial, qu'il importe de connaître pour l'intelligence de leurs écrits. Les passages suivants, quoique d'une époque plus moderne, jettent beaucoup de lumière sur ce point."

"On lit dans le traité *de Mineralibus*, prétendu d'Albert le Grand (L. I. tr. I, ch. I er): 'ce qui s'évapore au feu est esprit, âme, accident; ce qui ne s'évapore pas, corps et substance.'—"Coll. des Alch. Grecs," I. pp. 247-8. Cf. "Le cuivre est comme l'homme; il a corps et âme."—Introd. à la Chimie des Anciens, p. 294. See also, "La chimie au moyen Age," T. I. p. 73, and *ibid.* T. III. pp. 168-70; also *ante* p. 91.

and green vitriol respectively. The word *chalcanthum* was applied now to the one, now to the other.¹ In the Hindu Materia Medica no such confusion occurs. Even in the Charaka and the Susruta *tuttham* (blue vitriol) and *kāsisa* (green vitriol) are mentioned side by side.

BLUE VITRIOL

The word *tuttham* is generally applied to blue vitriol; in Rasendrasāraṅgraha and Sārṅgadhara, the following synonyms are given: तुत्थं के तु शिखियोव
हेमसार मयूरकं ।

R. R. S. uses *mayūratuttham* (मयूरतुत्थं) in Bk. ii. 129, which is a combination of the last and the first names in the above *sloka* *Sikhigrīvam* (lit.

(1) "Ich habe schon bei der Geschichte des Eisenvitriols darauf aufmerksam gemacht, welche Unsicherheit in den früheren Mittheilungen über Vitriol im Allgemeinen herrscht. Auch die älteren Angaben, welche am passendsten auf den Kupfervitriol bezogen werden, können zum theil auf Eisenvitriol gegañgen sein." "Ges. der Chem." IV. p. 168.

"Observons les sens divers de ce mot couperose [chalcanthon], ou de son équivalent vitriol, tels que : vitriol bleu : sulfate de cuivre ; vitriol vert: sulfate de fer, et sulfate de cuivre basique ; vitriol jaune te rouge : sulfates de fer basiques." "Coll. d. Grecs." I. pp.

resembling the neck of the peacock) is practically the same as “*mayūrakantha sachchhāyam*” in sloka, 127, i.e. having the play of colour in the throat of the peacock.

The term *sasyaka* as a synonym for blue vitriol does not occur in any other medico-chemical work that I have come across except *Rasārnava*.

That an essence in the shape of copper is yielded by blue vitriol is worthy of note from a historical point of view. *Rasārnava* very often hits upon it but is not so explicit as R. R. S., as it modestly contents itself with the mere assertion that the essence is of the colour of *Coccinella* insect i.e. red (see p. 86). In the *Bhāvaprakāsa* (ca. 1550 A.D.) occurs this remarkable passage: “तुल्यं तु तामोपधातुर्हि किञ्चित्सामेण तद्वत्” *blue vitriol is indeed a semimetal of copper as it is derived from copper*. The nomenclature itself is in wonderful agreement with that adopted nearly two centuries later by Boerhave¹ (1732 A. D.).

(1) “Die krystallisirten Verbindungen eines Metalls mit Säuren erkannte er nicht unbedingt als Salze an; die Vitriole namentlich rechnete er zu den Halbmetallen.” Kopp: “Ges. d. Chem. 111. p. 6.

Our knowledge of the nature of the "essence" of blue vitriol has thus been gradually advanced from *Rasārnava* downwards.¹

(1) "Basil Valentine" seems to have known that some vitriols contained copper, but his "blue vitriol" does not necessarily mean sulphate of copper. "Der blaue Vitriol. heisst bei Basilius vitriolum commune: was bei ihm Vitriolum Veneris gennant wird, ist oft Grünspan, und überhaupt geht diese Bezeichnung bei ältern schriftstellern auf sehr verschiedenartige Kupfersalze, wie denn Libavius in seiner Alchymia (1595) für die Bereitung des vitrioli Veneris vorschreibt....." Even Agricola (1494-1555), contemporary of Bháva does not make any great distinction between green and blue vitriol. "Agricola beschreibt in seiner Schrift *de re metallica* die Darstellung des Kupfrevitriols bei der des Eisenvitriols und des Alauns, ohne die beiden ersteren als wesentlich verschieden anzusehn, und auch in seiner Abhandlung "de natura 'fossilium'" unterscheidet er nur verschieden gefärbte, nicht aber wesentlich verschiedene Vitriole"..... "Ges. d. Chem." IV 170-171.

ON
Gunpowder, Saltpetre
AND THE
Mineral Acids

GUNPOWDER

The ancient Hindus are sometimes credited with the knowledge of the art of manufacturing gunpowder, in support of which the several recipes given in the *Sukranīti* or the Elements of Polity of *Sukrāchārya* which we have already had occasion to quote, are cited. Take for example the following :—

सूबर्चिलवचात् पञ्च पलानि गम्भकात् पञ्चम ।

अन्धूमविपक्षार्कसुद्धाद्वारतः पञ्चम् ॥ 201

यहात् संयात्ता संचूर्यं समोल्य प्रपुटेदसैः ।

बुद्धकाणां रसोनस्य शोषयेदातपेन च ।

पिहा शर्करवचे तदग्निचूर्चं भवेत् खलु ॥ 202

सुवर्चिलवचाहागा वज्रा चत्वार एव वा ।

नालास्त्रार्थाप्रिचूर्णे तु गम्भाहारौ तु पूर्ववत् ॥ 203

गोक्षी शीङ्गमयो गर्भंप्रटिकः केवलोऽपि वा ।

सौसस्य लघुनालादें लग्नधातुभनोऽपि वा ॥ 204

शोहसारमयं वापि नालास्त्रं लग्नधातुजम् ।

नित्यसम्मार्जनस्तद्धमस्तपातिभराहतम् ॥ 205

अङ्गारस्यैव गम्भस्य सुवर्चिलवणस्य च ।

शिखाया इरितालस्य तथा सौसमजस्य च ॥ 206

हिङ्गुसस्य तथा कान्तरजसः कर्पूरस्य च ।

जटीर्णौल्याश सरलनिर्यासस्य तथैव च ॥ 207

समन्यूनाधिकैरश्चैरप्रिचूर्णन्यनेकशः ।

कल्पयन्ति च तहिदाशन्दिकाभादिमन्ति च ॥ 208

चिपन्ति चाप्रिसंयोगाङ्गोलं लक्ष्ये सुनालगम् ॥ 209

नालास्त्रं शोधयैदादौ दद्यात्तवाप्रिचूर्णकम् ।

निवेशयैत्तद्वेगं नालमूले यथा ददम् ॥ 210

ततः सुगोलकं दद्यात् ततः कर्णेऽप्रिचूर्णकम् ।

कर्णचूर्णप्रिदानेन गोलं लक्ष्ये निपातयेत् ॥ 211

"Take five *palas* of saltpetre, one *pala* of sulphur and one *pala* of charcoal, prepared from the wood of *Calotropis gigantea* and *Euphorbia neriifolia* by destructive distillation⁽²⁾; powder them and mix them intimately and macerate them in the juice of the above-named plants and of garlic and afterwards dry the mixture in the sun and pulverise it to the fineness of sugar. Gunpowder (lit. fire-powder) is thus obtained. 201-202

"If the fire-powder is to be used for a gun, six or four *palas* of saltpetre are to be taken, the proportion of charcoal and sulphur remaining the same as before. 203

"For a gun with a light barrel, balls of iron or of other metals are to be used. 204

"The gun made of iron or of other metals are to be constantly kept clean and bright by the skilful artillerymen. 205

By varying the proportions of the ingredients, viz., charcoal, sulphur, saltpetre, realgar, orpiment, calx of lead, asafœtida, iron powder, camphor, lac, indigo and the resin of *Shorea robusta*, different

(2) अचर्क्षसविपक्तः lit., (wood) charred by smoke circulating through it.

kinds of fires are devised by the pyrotechnists giving forth flashes of starlight." 206-208

From the circumstantial details given above, especially of the method of preparing the charcoal, one is naturally led to suspect that the lines relating to gunpowder as quoted above are later interpolations. The suspicion is further enhanced when it is borne in mind that in the Polity of Kāmandakī, an ancient work of undoubted authenticity, there occurs no reference whatever to firearms nor is there any in the Agnipurāna in which the subject of training in the use of arms and armours takes up four chapters, archery forming the leading element.¹

The more rational conclusion would be that the *Sukranīti* is a patch work in which portions of chapter IV were added some time after the introduction of gunpowder in Indian warfare during the Moslem period.² Dr. G. Oppert, however, stands up for its antiquity.

In Halhed's "Code of Gentoo Laws," there is a passage which is sometimes quoted as a proof that

(1) See Intro. to Dr. R. L. Mitra's edition of *Agnipurāna*.

(2) Dr. R. L. Mitra, judging from the description of guns alone, concludes this portion to be spurious;—*vide* Notices of Sanskrit MSS. Vol. V, p. 135.

M. Berthelot's concluding remarks on Marcus Græcus' "Book of Fire" are equally applicable to *Sukraniti* :—

the ancient Hindus knew the use of firearms. Halhed, not having an acquaintance with Sanskrit, had to depend on the Persian translation of the Sanskrit digest prepared by some learned pundits. We have been at some pains in finding out the original text which is generally credited to Manu. It is only by a forced interpretation that anything in Manu may be taken to refer to a projectile discharged from a gun.¹

"Mais je n'insiste pas, si ce n'est pour rappeler comment ces additions manifestent le caractère véritable de la composition de ces manuscrit et livres de recettes, déjà répandus dans l'antiquité et dont les formules sont venues jusqu'au XVIII^e siècle, parfois même jusqu'à notre temps. Le *Liber ignium* en est un exemple, et l'analyse précédente montre bien comme il a été composé avec des matériaux de dates multiples, les uns remontant à l'antiquité, les autres ajoutés à diverses époques, dont les dernières étaient contemporaines, ou très voisines de celle de la transcription de chaque manuscrit." "La Chimie au moyen Âge" T. I. 135.

(I) The passage in Manu runs thus :

न कूटेरायुधेऽच्याद युध्यमानो रणे रिपून् ।

न वर्षिभिर्नापि दिग्भेनांग्निभिततेजनेः ॥ मनु, VII. 90

We give below the commentaries of Medhátithi and Kullüka
Bhatta :—

In Sanskrit literature, there are frequent but vague references to 'agni astra" or firearms, but we have no reason to suppose that the combustible matter these fire arms contained supplied a motive power of the nature of gunpowder. The fire missiles were probably of the same category as the

कूटानि यानि वहिः काष्ठमयानि अतर्निश्चितशस्त्रानि । कर्पिषः शराः, वे
श्लथस्य मूले मध्यं वा कण्ठांकारेः क्रियन्ते । ते हि प्रविष्टा दुष्कृता भवन्ति,
प्रहारैरभिन्नमपि शरीरैसदेशं भिन्नति । दिग्धाविषोपलिसाः । अग्निना
ज्वर्ज्वलतमादीपितं तेजोमयफलकं येषा, एतेन्द्रीयस्यम् । इति निष्पत्तिधिः ।

कूटान्यायुधानि वहिः काष्ठादिमयानि, अतर्निश्चितशस्त्राणि तः समरे
युद्धमानः शब्दून् न इच्छात् ; नापि कण्ठांकारफलकोर्णपि विषाक्तोर्णप्यग्निप्रदी-
मफलकैरिष्यन्तः । इति कृष्णकभइः ।

The correct rendering should be as follows:—"The king shall not slay his enemies in warfare with deceitful or barbed or poisoned weapons, nor with any having a blade *made red hot by fire* or tipped with burning materials"; Bühler, who also follows the above commentators, thus translates: "when he (the king) fights with his foes in battle, let him not strike with weapons concealed (in wood), nor with (such as are) barbed, poisoned, or the points of which are blazing with fire." Whereas Halhed's version is: "the magistrate shall not make war with any deceitful machine or with poisoned weapons or with cannon and guns or with any other kind of firearms."

'Greek fire,' *i.e.* arrows or darts tipped with oiled flax, resin, regalar, naptha or other bituminous substances discharged from bows ; sometimes elaborate machines being devised to hurl the weapons with more deadly effect. In the *Udyogaparava* of the *Mahābhārata*, Yudhisthira is described as "collecting large quantities of resin, tow, and other inflammable articles for his great fratricidal war."¹ But there is nothing to show that gunpowder of any sort was in use or any chemical which would act as a propelling agent.²

The mention of gunpowder and of some sort of explosives with identical formularies occurs almost simultaneously in the Latin redaction of the work on

(1) See Dr. Mitra's "Antiquities of Orissa," 1.121.

(2) In the 11th century, Kūsmīr remained safe behind its mountain ramparts and was hermetically sealed to all foreigners without exception. Here, according to Albfrúni, Hindu sciences retired and took shelter when the Mohammedan invasion of India began. But in the indigenous mode of warfare no reference to gunpowder is to be found ; thus we read in Kalhana's *Rajatarafinī* that in 1090 A. D. "he (Kandarpa) threw into the mêlée burning arrows smeared over with vegetable oil, struck by which the enemies caught fire. Believing that he knew [the use of] the weapon of fire (*agneya astra*), they became frightened and fled in bewilderment, cursing their return."

"Fire" by Marcus Græcus and in the writings of Roger Bacon about the 13th century.¹ Greek fire was introduced into Constantinople from the East about the year 673 and the Byzantians evidently knew that saltpetre was its basis; but they kept this knowledge strictly a secret, and abstained from speaking of it by any distinct name lest the information might leak out. Thus the very word saltpetre

The original passage is

ततसानथ नाराचान् निचिदेप स मंयुगे ।

लिप्तानौषधितैलेन विज्ञा ये: प्राञ्जलन् दिशः ॥

आद्येयं वेत्यसावस्त्रमिति मूर्खो विश्विताः ।

ते दूरं प्रयग्युभीता निन्दत्वः पुन रागमम् ।

VII. 983, 989.

For further references to similar fire-missiles see Mahānātaka or Hanumāna Nātaka in Wilson's "Hindu Theatre," Vol. II. ed. 1835, appendix, pp. 369-70.

The first record of the use of cannon and gunpowder in Indian warfare is in the memoirs of Baber. In 1528 he forced the passage of the Ganges near Kanauj with the aid of artillery. For much valuable information on the subject of the early Asiatic fire-weapons the reader may consult an exhaustive article by Maj. Gen. R. Maclagan in the "Journ. As. Soc., Bengal," Vol. XLV. pp. 30 ff.

(1) "La Chimie au moyen" âge, I. p. 94.

is conspicuous by its absence in the literature of the ancients. Nitrum (natron) was all along exclusively applied to carbonate of soda.¹

SALTPETRE.

It will thus be seen that there is much in common in the history of the word used for nitrate of potash both in the Sanskrit and in the Latin languages, as in the former "sauvarchala" and "yavakshāra" are indiscriminately applied to it.

It is very remarkable that in the later Sanskrit chemico-medical literature the very word sauvarchala, which stands for saltpetre in the *Sukranīti* and in the *Rasārnava*, ceases altogether to be applied to it, but is used as a synonym of sārjikā (natron), while yavakshāra has been pressed into service, it being clean forgotten that from the time of Charaka and Susruta this word has been used

(1) Cf. "C'est par erreur que la plupart des éditeurs des auteurs grecs ou latins traduisent ces mots par nitre ou salpêtre, substance presque inconnue dans l'antiquité, et que apparaît seulement à partir du VI^e siècle à Constantinople, avec le feu grégeois dont elle était la base. Les anciens parlent aussi du nitrum factice, préparé avec es cendres de chêne, c'est-à-dire du carbonate de potasse."—"Intro la l'étude de la Chimie," p. 263.

in its radical sense, *viz.*, the *ashes of barley* (impure carbonate of potash, from *yava*, barley and *kshāra*, ashes). Both Wilson and Monier Williams in their Sanskrit-English Dictionaries, following no doubt the authority of modern writers, erroneously render *yavakhāra* as saltpetre as also does Colebrooke in his "Amarakosha". Roth and Böhlingk in their Wörterbuch, however, correctly translate it as "Aetzkali, ous der Asche von Gerstenstroh."

It is strange indeed that a substance which occurs extensively in Bengal and in upper India as an efflorescence on the soil should have been allowed to go without a definite name for several centuries.⁴ Dutt says "nitre was unknown to the ancient Hindus. There is no recognised name for it in Sanskrit."⁵ * * * Some recent Sanskrit

(I) In the chemistry of Bubacar, "le sel de cendres" is the equivalent of *yavakshára*—*"La Chimie au moyen Âge,"* 1. 308.

(2) We purposely use the words "allowed to go without a definite name," for the term *sauvarchala* was all along vaguely used now for saltpetre, now for natron.

(3) He is in error on this point, as he had not consulted, or probably had no acquaintance with, the old literature on the subject. Prof. Macdonell very properly points out "the dangers of the *argumentum ex silentio* [as] furnished by the fact that salt, the most necessary of minerals, is never once mentioned in the *Rig-*

formulas for the preparation of mineral acids containing nitre mention this salt under the name of "soraka". This word, however, is not met with in any Sanskrit dictionary and is evidently sanskritized from the vernacular *sorā*, a term of foreign origin. The manufacture of nitre was therefore most probably introduced into India after the adoption of gunpowder as an implement of warfare."¹ Mat. Med. of the Hindus, pp. 89-90, ed. 1900.

veda. And yet the northern Panjab is the very part of India where it most abounds. It occurs in the salt range between the Indus and the Jhelum in such quantities that the Greek companions of Alexander according to Strabo, asserted the supply to be sufficient for the wants of the whole of India." It would be equally hazardous to rush to the conclusion that nitre was "unknown" to the Hindus.

(1) Dutt is probably correct in so far as he states his views with regard to "the manufacture of nitre" as an ingredient of gunpowder. For it is well known saltpetre has been in use from time immemorial as the basis of rocket and other fireworks both in China and India. In the *Dasakumáracharita* by Dandí, mention is made of *yogavartiká* (magic wick) and *yagachúrṇa* (magic powder), of which saltpetre was probably the basis. The earliest account of the manufacture of saltpetre on a commercial scale that we have come across occurs in a rare work entitled: "The Travels of John Albert de Mandelso from Persia into the East Indies. London, 1669." The book is in the valuable collection of my friend, Mr. Prithvisa Chandra Ráya. Says our author:—

MINERAL ACIDS.

Geber was up till recently credited with being the discoverer of nitric acid, aqua regia, silver nitrate &c. A careful examination of the works of Geber, both real and pretended, notably of the celebrated *Summa perfectionis magisterii*, has convinced M. Berthelot that the knowledge of the mineral acids was unknown not only to the Arabs but also to the European alchemists of the thirteenth century. It was a Latin author of the latter half of the 13th century who wrote the above memorable work and assumed the

" Most of the *salt peter* which is sold in *Gusuratta* comes from *Ajmer*, sixty Leagues from *Agra*, and they get it out of Land that hath lain long fallow. The blackest and fattest ground yields most of it, though other Lands afford some, and it is made thus: they make certain trenches which they fill with their Saltpetrous Earth, and let into them small Rivulets, as much water as will serve for its soaking, which may be the more effectually done, they make use of their feet, treading it till it becomes a Broath. When the Water hath drawn out all the salt-peter which was in the Earth, they take the clearest part of it, and dispose it into another Trench, where it grows thick, and then they boil it like salt, continually scumming it, and then they put it into earthen pots, wherein the remainder of the Dregs goes to the bottom; and when the water begins to thicken, they take it out of these pots, to set it a-drying in the sun, where it grows hard, and is reduced into that form wherein it is brought into *Europe*." pp. 66-67.

venerable name of Geber to gain public confidence.¹ Such instances of literary forgery are by no means uncommon in the alchemical literature of the East and the West.

The distillation of alum is referred to in *Rasārnava* and of green vitriol in R.R.S. (see pp. 71, 92) We have, however, no evidence that the acid thus derived was ever used as a solvent. Hoefer justly remarks that real progress in chemistry was impossible in India and China, as the preparation of mineral acids was unknown in both these countries.² At the same time we should remember that *Rasārnava* and similar other works lay stress upon *vida*, in which aqua regia may be said to be potentially present and which is fitly described as capable of "killing all the metals" (see p. 72)

The preparation of mineral acids is incidentally described in several exclusively medical works, composed probably in the 16th and 17th centuries, e. g. "*Rasakaumudi*" by Mādhava, *Rasaratnapradipa*, and "*Bhaishajyaratnāvali*" by Govindadāsa, &c. In

(1) "L'hypothèse la plus vraisemblable à mes yeux, c'est qu'un auteur latin, resté inconnu, a écrit ce livre dans la seconde moitié du XIII^e siècle, et l'a mis sous le patronage du nom vénéré de Géber." "La Chimie au moyen âge," I. 349.

(2) "Hist. de la Chimie," T. I. p. 25, ed. 1866.

the last work under the heading of mahādrāvaka-rasa, directions are given for distilling a mixture of among other things, alum, green vitriol, salammoniac salt-petre and borax in a glass retort. In this way a dilute solution of nitro-muriatic acid is obtained, which is prescribed in derangement of liver and spleen. We have a similar recipe in which in addition to the above ingredients, rock-salt and sea-salt are used, thus yielding what is called "samkhadrāvaka" (lit. solvent for conch-shell.)

The term "drāvaka" (solvent) seems to have been expressly coined to do duty for the mineral acids. We have seen all along that in the older works drāvaka was used invariably in the sense of solvent or flux (see p. 130), but never in the sense of a mineral acid, the knowledge of which seems to have spread both in the East and the West almost simultaneously. The regular application of the mineral acids to technical operations dates from the time of the Emperor Akbar or perhaps a little earlier. Thus in the *A'in-i-A'kbari* under the "Method of Refining Silver" mention is made of the use of *rasi* (aqua fortis). It is not easy to make out how much of the processes of the assay of gold and silver as described in the *A'in* is of Hindu origin.

Royle, Sir W. O'Shaughnessy ("Manual of

Chemistry"), Ainslie and others maintained that the Hindus were acquainted with the methods of preparing the mineral acids. These authors who wrote more than half-a-century ago derived their information at second-hand as none of them had probably read the Sankrit works in the original. Ainslie gives the following recipes as used in Southern India among the Tamil physicians for the preparation of sulphuric, nitric and muriatic acids respectively :

Sulphuric acid : "The Tamil physicians prepared their article nearly in the same way that we do, *viz.*, by burning sulphur with a small with a small piece of nitre in strong earthen vessels."

O'Shaughnessy says : "sulphuric acid, the *Gun-dak ká áttar* of the Hindus has long been known among the Eastern nations. In southern India it has been prepared for many centuries."

Nitric acid : This acid the Hindus make a clumsy attempt at preparing in the following manner which must not be rigidly criticised by the chemists of Europe.

Take of saltpetre	20 parts.
„ alum	16 „
„ the acid liquid from the leaves and stem of the Bengal horsegram	18 „,

Mix and distil with an increasing heat till the whole of the acid is condensed in a receiver.

Muriatic acid : 'Take of
 common salt ,, 8 parts
 alum ,, 6 parts

The acid liquid from the horse gram and distil &c.'

The very name of sulphuric acid, *Gundak ká áttar* is Urdu i.e. the hybrid *lingua franca*, an admixture of Hindi with Persian. *Attar* in Persian means the volatile principle, often odoriferous, e.g. *Guláb ká áttar* i.e. otto de Rose. "Gundhak" in Sanskrit is the equivalent for sulphur.

Knowledge of Technical Arts

AND

Decline of Scientific Spirit

In ancient India the useful arts and sciences, as distinguished from mere handicrafts, were cultivated by the higher classes. In the White Yajur-Veda and in the Taittirīya Brāhmaṇa, we meet with the names of various professions which throw light on the state of society of that period ; unfortunately a knowledge of these perished with the institution of the caste system in its most rigid form.¹ Among the sixty-four “kalās” or arts and sciences which are enumerated in the old work of Vātsāyana² called Kāmasūtra occur the names of the following :

(1) See Dutt's “Civilization in Ancient India,” pp. 155-157, Calcutta ed.

(2) “Vātsāyana is another old authority.....The name occurs in Pāṇini 4. 1. 73. and probably the author of the Kāmasutras was meant as some of his rules refer to terms chiefly used in the latter. The text has come down to us almost undefiled, showing its great popularity among our ancestors, which is also clear from its commentaries and reference by Dandī, Vāmaṇa and other great writers.”—Preface to Barua's “Amarakosha,” preface, xiii.

सुवर्चरबपरोक्षा :—or the examination and valuation of gold and gems.

धातुवादः or chemistry and metallurgy.

माण्डरामाकरशान्म् :—or knowledge of the colouring of gems and jewels, as also of mines and quarries.

In the *Sukranītisāra* or the Elements of Polity by *Sukrāchārya*, we also read an account of the various “*kalās*” : e.g.

पाषाणधात्रादिहतिसदभस्तोकरणं कला :—“the art of piercing and incinerating the stones and the metals is known as a “*kalā*.”

धात्यौषधीनां संयोगक्रियाशानं कला चृता :—“a knowledge of the combinations of the metals and the herbs and the plants is also regarded as a “*kalā*.”

धातुसार्वथ्यपार्थक्यकरणन्तु कला चृता ।

संयोगापूर्वविज्ञानं धात्रादीनां कला चृता ॥

“The art of alloying and separating the metals is also known as a “*kalā*.”

चारनिष्कासनशानं कलासंज्ञन्तु तत् चृतम् ।

कलादवक्षेत्रिणि लायुर्वेदाग्नेष च ॥

“The art of extracting alkali (see pp. 31-38 under *Susruta*) is likewise counted as a “*kalā*”. In the science of *Āyurveda*, there are altogether ten “*kalās*”.

We also find that among the companions of the poet Vāna were an assayer and a metallurgist.¹ Such terms as "lohavid" and "dhātuvid" which occur repeatedly in Sanskrit literature show that the metallurgists were held in high esteem and expert knowledge sought after.

The art of dyeing was carried almost to perfection, the fast colours resembling the Tyrean purple.

In the Vedic age the *Rishis* or priests did not form an exclusive caste of their own but followed different professions according to their convenience or natural tastes, thus fulfilling the ideal laid down by Emerson : "Has he (man) not a *calling* in his character? Each man has his own vocation. The talent is the call." But all this was changed when the Brāhmins reasserted their supremacy on the decline or the expulsion of Buddhism.

The caste system was established *de novo* in a more rigid form. The drift of Manu and of the later *Purānas* is in the direction of glorifying the priestly class, which set up most arrogant and outrageous pretensions. According to Susruta, the dissection of dead bodies is a *sine qua non* to the student of surgery and this high authority lays par-

(1) Cowell and Thoma's Trans. of Harsha-charita, p. 33.

cular stress on knowledge gained from experiment and observation.¹ But Manu would have none of it. The very touch of a corpse, according to Manu, is enough to bring contamination to the sacred person of Brāhma.² Thus we find that shortly after the time of Vāgbhāta, the handling of a lancet was discouraged and Anatomy and Surgery fell into disuse and became to all intents and purposes lost sciences to the Hindus. It was considered equally undignified to sweat away at the forge like a Cyclops. Hence the cultivation of the *kalās* by the more refined classes of the society of which we get such vivid pictures in the ancient Sanskrit literature

(1) त्वक्पञ्चतस्य देहस्य योऽयमङ्गवि निषयः ।
श्ल्यश्लामाद्वै नेष वर्णनेऽङ्गेषु केषुचित् ॥
तथाप्तिःश्च शानं श्वर्णं श्ल्यस्य बाज्जता ।
योधयित्वा वृत्तं सम्यग् इष्ट्योऽङ्गविनिषयः ॥
प्रत्यक्षतो हि यदइष्टं शास्त्रं च यहवेत् ।
समाप्तस्तुभयं भूयो शानविवर्जनम् ॥ 43-45

* * * * *

शरीरे चेद शास्त्रे च हृष्टार्थः स्याद्विशारदः ।
हृष्टशुताभ्यां सन्देहमवापोऽप्यचरेत् कियाः ॥ 48

Sáriira. Ch. V.

(2) The "Laws of Manu," V. 64,85,87.

has survived only in traditions since a very long time past.¹

(1) Similar dangers have threatened Europe from time to time but her sturdy sons have proved better of them in the long run. Thus "Aristotle's opinion that 'industrial work tends to lower the standard of thought' was certainly of influence here. In accordance with this dictum the educated Greeks held aloof from the observation and practice of technical chemical processes; a theoretical explanation of the reactions involved in these lay outside their circle of interest."—Meyer's "Hist. of Chemistry," trans. by McGowan, p. 10, ed. 1898.

Paracelsus flings a sneer at the physicians of his time and compares them with the alchemists in the following terms : "For they are not given to idleness nor go in a proud habit, or plush and velvet garments, often showing their rings upon their fingers or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labours, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreations but take delight in their laboratory. They wear leather garments with a pouch, and an apron wherewith they wipe their hands. They put their fingers amongst coals, into clay, and filth, not into gold rings. They are sooty and black like smiths and colliers, and do not pride themselves upon clean and beautiful faces."—Quoted by Rodwell in his "Birth of Chemistry."

Even so late as the middle of the last century, the pursuit of Chemistry in England was not regarded in a serious light and "chemists were ashamed to call themselves so because the apothecaries had appropriated the name"—a circumstance which led Liebig in 1837 to declare "that England was not the land of science."

The arts being thus relegated to the low castes and the professions made hereditary, a certain degree of fineness, delicacy and deftness in manipulation was no doubt secured but this was done at a terrible cost. The intellectual portion of the community being thus withdrawn from active participation in the arts, the *how and why* of phenomena—the coördination of cause and effect—were lost sight of—the spirit of enquiry gradually died out among a nation naturally prone to speculation and metaphysical subtleties and India for once bade adieu to experimental and inductive sciences.¹ Her soil was rendered morally unfit for the birth of a Boyle, a Des Cartes or a Newton and her very name was

(1) The Vadánta philosophy, as modified and expanded by Samkara, which teaches the unreality of the material world, is also to a large extent responsible for bringing the study of physical science into disrepute. Samkara is unsparing in his strictures on Kanúda and his system. One or two extract from Samkara's Commentary on the Vedánta Sútras, will make the point clear :

“तथादेव सारतरत्कं संहस्रतः। ईश्वरकारणशातविश्वलात्, श्रुतिपद-
स्थेष शिष्टेभन्नादिभिरपर्यग्नीतत्वात्, अत्यन्तमेवाऽनपेक्षाक्षिण् परमाणुका-
रणवादे कार्याद्येः शेषोऽर्थभिरिति बाक्षयेषः। ११११० सूत्रभाष्यम्।
वेदाधिकराद्वान्ती दुर्युक्तियोगाद् वेदविदोधात्, शिष्टापरिवद्वाच जपेष्वितम्
इत्युक्तं सोऽर्थवेनाश्रित इति वेनाश्रितसाम्यात् सर्ववेनाश्रित-राद्वान्ती
नितरामनपेक्षितम् इतीदं ईदानीं उपपादयामः। ११११८ सूत्रभाष्यम्।
“Vedánta Darsana,” Bombay ed.

all but expunged from the map of the scientific world.¹

In this land of intellectual torpor and stagnation the artizan classes, left very much to themselves and guided solely by their mother wit and sound commonsense, which is their only heritage in this

"It thus appears that the atomic doctrine is supposed by very weak arguments only, is opposed to those scriptural passages which declare the Lord to be the general cause, and is not accepted by any of the authorities taking their stand on scripture, such as Manu and others. Hence it is to be altogether disregarded by high-minded men who have a regard for their own spiritual welfare." *Il. 2, 17*

"The reasons on account of which the doctrine of the Vaise-shikas cannot be accepted have been stated above. That doctrine may be called semi-destructive (or semi-nihilistic)." Thibaut's trans., *Ibid.* 18.

(1) Among a people ridden by caste and hide-bound by the authorities and injunctions of the *Vedas*, *Upanishads*, and *Smritis* and having their intellect thus cramped and paralysed, no Boyle could arise to lay down such sound principles for guidance as :

P. XXVI. ". . . I saw that several chymists had, by a laudable diligence obtain'd various productions, hit upon many more phenomena, consideral'le in their kind, than could well be expected from their narrow principles : but finding the generality of those addicted to chymistry, to have had scarce any view, but to the preparation of medicines, or to the improving of metals, I was tempted to consider the art, not as a physician or an alchymist, but a philosopher. And, with this view, I once drew up a scheme

world, have kept up the old traditions.¹ In their own way they display marvellous skill in damascening, making ornamental designs on metals, carving on ivory, enamelling, weaving, dyeing lace-making, goldsmith's and jeweller's works, etc.²

The successive stages in the manipulation of one branch of the arts have been carefully watched by Mr. Jñānasarana Chakravartī M. A., late Scholar, Presidency College, and his experiences embodied in a paper, which, for the most part, is reproduced below with certain alterations; it is of singular interest as a contribution to the history of the Indian technical arts. It now remains only to add that some of the processes described below were in

for a chymical philosophy; which I shou'd be glad that any experiments or observations of mine might any way contribute to complete.'

P. XVIII. ". . . And, truly, if men were willing to regard the advancement of philosophy, more than their own reputations, it were easy to make them sensible, that one of the most considerable sevices they could do the world is, to set themselves diligently to make experiments, and collect observations, without attempting to establish theories upon them, before they have taken notice of all the phenomena that are to be solved." Shaw's ed. of Boyle's works, 3 vols. 1725.

(1) Vide manufacture of alum, pp. 147-51.

(2) For detailed information on some of these branches the reader may consult Birdwood's Industrial "Arts of India".

vogue at the time of the Emperor Akbar and probably existed long before, as *Rasārnava* amply testifies (p. 68). The very terms "*poonoon*" (*pun-hār*) and "*Neharwalla*" (*Nīriyah*) occur in the descriptions of the assay of gold in *Ain-i-Akbari*.¹

The wastage of Gold in the course of Preparing Jewelry in Bengal²

SOLDERING

The next process that we shall consider is soldering. This is undoubtedly the most important process that the goldsmith has to perform from a commercial point of view. It is in the course of this process that the practical goldsmith plays those

(1) Along with Mr. Chakravarti's Essay should be read *Ains* 7, 8 and 9 "on the Manner of Refining Gold," "the Method of Refining Silver" "and the Method of Separating the Silver from the Gold," Blochmann's trans. Vol. 1. pp. 20-25.

(2) "Indian Engineering." XIX (1896). The Mechanical Operations of Melting and Hammering have been left out.

mischiefous tricks which go so hard against those who purchase his productions or order for them. The quality or quantity of solder (or *pān*) employed is the first question that is universally enquired into in all cases of commercial dealings in Indian jewelry; and while by melting some articles the value of the gold per tola is reduced by Re. 1 or 2 only, we frequently find cases in which the value is decreased at the ruinous rate of Rs. 8 or Rs. 10. This last state of affairs arises when the solder consists almost entirely of a mixture of baser metals and is at the same time fraudulently used in larger quantities than what is absolutely necessary.

Considered, however, from the standpoint of a chemical student who investigates the subject of ascertaining the amount of metal that is lost in the operations of the goldsmith, the process of soldering is scarcely important enough to receive a separate treatment. The preparation of the solder and its reduction to the condition of small thin bits are embraced in the discussion of melting and hammering; while the loss during the blowing operation, during which the reducing flame of an oil lamp is made to play upon the solder and the parts it is meant to join together, may be supposed

to have been treated during the discussion of the subject of loss of gold by volatilisation. The fact that almost all solders contain a little zinc perhaps makes the loss in their case to be much greater than in that of an alloy of gold and copper only. The following three sets of figures give the weight of gold and the weight of solder before the process of soldering and the weight of the article after the operation has been finished :—

Gold			Solder			Wt. of Gold & Solder after operation.		
Tolas	annas	pies.	Tolas	annas	pies.	Tolas	annas	pies
6	0	0	1	0	0	6	15	0
2	0	0	0	8	0	2	7	13/4
3	8	0	1	4	0	4	10	3

Thus, on the whole a loss of $1\frac{1}{4}$ pies takes place in dealing with $1\frac{1}{4}$ tolas of materials. This gives the rate of loss at 79 pies per tola.

It is proper to observe that of the loss that takes place during soldering, about one-third is due to purely physical causes, *e. g.* the loss of pieces of solder which fly off before the blowpipe. The above figures are accordingly not to be supposed as affording an accurate estimate of the amount of material that is lost by vapourisation during the operation of soldering.

FILING AND CUTTING

These are the two operations of the goldsmith in the course of which gold is lost to an appreciable extent. The work of cutting is done by a class of men called *nakāshiwalās* to whom the articles are made over for the purpose. In recognition of the fact that loss of gold must inevitably take place during the operation of cutting, the goldsmith, when he takes back the articles and the particles that are chopped off the surface from the *nakāshiwalās*, generally makes an allowance of one pie per tola in favour of the latter.

The loss which takes place during the operation of cutting as well as the loss during filing, i.e. rubbing the surface of gold with a steel file to make it smooth, is due to causes of a purely mechanical nature and can be prevented to a great extent by the means suggested for minimising such loss in the course of hammering and drawing.

The operation of cutting is always, and that of filing sometimes, effected after the article has been coloured and polished. But as the chemical process of colouring will be treated of separately in the following pages, the mere mechanical operation

of cutting and filing are here put in for the purpose of preserving continuity.

THE CHEMICAL OPERATIONS OF THE GOLDSMITH : CLEANSING, COLOURING AND POLISHING

We now come to a process which, though not so important in the eyes of the goldsmith as some of the processes before described, is yet of the greatest consequence in the enquiry in which we are engaged. This is the process of colouring.

If it were possible for our goldsmiths to work with pure gold, the appearance of the material would suffer very little by the various processes of heating, hammering, &c., and a mere mechanical rubbing would throw off the superficial dirt and be sufficient to expose the natural yellow surface of the unalloyed metal. This property of pure gold is due to the fact that no oxides of gold are formed at temperatures to which the metal is exposed during the operations of the goldsmith. Indeed it is well-known that gold does not unite with oxygen at any temperature.

But the case is different with copper, the oxide of which is formed at temperatures which are ordinarily attained by the goldsmith in the course of his operations. Hence, if a mass of copper is

heated in the goldsmith's fire, it is divested of its bright red colour and acquires a dirty black appearance due to the formation of a coating of cupric oxide. Now, an alloy is nothing but an intimate mechanical mixture of its constituent metals—the molecules of the several metals lying promiscuously as it were. In an alloy of gold accordingly in which copper forms a constituent part, the particles of the latter are freely interspersed between those of gold. When such a substance is heated in air, the gold particles retain their primitive yellow, but the particles of copper, which are exposed to air, are oxidised into CuO. This substance is, as we know, a black amorphous powder and it gives to the whole mass a black appearance, which becomes darker as the metal is hammered over and the powder is thoroughly spread over the surface of the metal.

An interesting and rather curious experiment clearly illustrates the above explanation. If a piece of gold containing a little copper be heated in air and care be taken not to rub the metal in any way so as to spread the black oxide of copper over the surface, it will be found that the metal, if free from external dirt or soot, will be still yellow and tolerably bright. The yellow of the more numerous gold particles overpowers the colour of the black

oxide of copper. If, however, this black substance be spread over the surface of the metal, the colour instantly changes. The spreading of the oxide is easily brought about by hammering, and thus we can take an apparently bright piece of metal and, by hammering reduce it to a jet black mass.

The ignorant goldsmiths explain this blackening by supposing the stain of the black steel hammer to adhere to the surface of gold.

We may, perhaps, in this connection mention a particular artifice which is sometimes employed by our goldsmiths to cleanse the surface of a gold and copper alloy, which has been blackened by fire. This method is employed whenever it is desirable in the course of working to expose the bright surface, but where it would be inconvenient, impossible or unnecessary to apply the long and laborious mode of cleansing or colouring which we shall hereafter describe. It is found that if a blackened piece of gold and copper alloy be heated in a charcoal fire to redness and then water be sprinkled on the fire, the alloy at once acquires the bright colour of gold. This phenomenon, though often practised by our goldsmiths, is a puzzle to the most intelligent among them. * * * * * The true explanation of the operation seems to be

that, when placed in a charcoal fire, the cupric oxide is reduced to metallic copper. But if it is taken out when hot, it comes into contact with the air again and is oxidised. What the goldsmith does is to suddenly cool down the metal when in the reduced state and not to allow it to come into contact with the open air, until it has cooled sufficiently down, so as not to be liable to re-oxidisation.

From what has been stated above, it will be easily seen that when a piece of golden ornament has been completed by the manufacturer, it is of a dirty dark colour and must be cleansed before it can be used. In this country mere cleansing is not sufficient, for the popular taste does not approve the new golden articles appearing and being used in the yellow colour of true gold. The articles must be "coloured" before they can be made over to the customer, by which is meant that a bright reddish colour must be imparted to them. The particular tinge which is liked by different persons is different, some people liking a colour verging very nearly on red or orange, while others have a fancy for a colour whfch approaches to reddish violet.

The process of imparting the requisite shade of colour to articles of gold is one of the most

cumbrous and complicated chemical operations in the whole range of indigenous arts and manufactures of India. The numerous chemical reactions that take place in the several stages of the business are of more than ordinary interest; while the immense loss of gold that apparently takes place leads one to wonder why the subject has not as yet been taken up seriously by commercial or scientific men.

The process of colouring, so recently as 20 years ago, was universally carried out by the goldsmiths themselves, and in the villages and smaller towns the state of affairs is still the same. But in the metropolis and at the bigger stations of the province, the advantages of the principle of division of labour have lately begun to be felt in every branch of art and manufacture, and the result, so far as this particular subject is concerned, has been the springing up of a class of people whose sole business is to colour ornaments and other articles of gold. These men are known among our goldsmiths as the *rungwala*s. They do not charge any remuneration for their labour, but retain the fluid in which, during the process of colouring, a quantity of gold is dissolved.

We will now follow the *rungwala* through the course of a complete set of processes for colouring,

skipping over the mere mechanical parts of the work, but dealing a little fully with the portions which are of a chemical nature.

THE PROCESSES OF THE RUNGWALA

The shop of a Calcutta *rungwala* is one of the most miserably furnished working-places in the whole metropolis. A charcoal fire, a pair of bellows, a few crude pieces of indigenous earthen-ware, two or three coarse pots of China, together with a few other little things, are all that greet the eager sight of the observer whom business or curiosity leads to his dark and ill-ventilated den.

The *rungwala* has to wait till a sufficient number of golden articles are accumulated in his hands. He does not generally commence the process until he has got at least ten tolas of gold for colouring. Because the cost, the trouble and the time required, as he says, in going through a complete series of operations are such as to prohibit his doing the work with a smaller amount of gold at a time. Ordinarily a "khola", as the amount of gold coloured at one operation is called, consists of about 20 to 30 tolas of gold.

Having got the amount of gold sufficient for working a *khola*, the first thing that the *rungwala*

has to do is to cleanse the articles of all external dirt as well as of the blackess due to the formation of CuO. With this view he first heats them in a charcoal fire, thus causing all the oil, charcoal dust, and other foreign substances on the surface to burn off. He next puts an earthen vessel on his fire and boils in it about a seer of the unripe fruit of tamarind (*Tamarindus Indica*), a sustance containing considerable amount of tartaric and other acids in the free state. Taking out these boiled articles and squeezing them so as to extract the extremely acid pulp he forms a thick syrupy fluid. In this fluid he boils the articles till the dilute acids dissolve away the cupric oxide, leaving a yellow surface of pure gold. It is found that the solution of tamarind pulp becomes distinctly blue in vitrue of the formation of copper salts.

In the place of this rather clumsy mode of cleansing, which is largely practised even in the metropolis, some of the more adventurous *rungwalias* use a rather more clever and neater method. Instead of preparing a large amount of tamarind pulp they obtain from the grocer's an ounce or two of a dull white crystalline substance which they call "acid," and a solution of this serves equally well, if not better, for their purpose. To the question

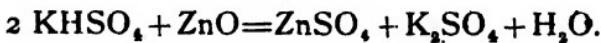
as to what the substance called "acid is, they cannot give a satisfactory reply. And even the grocer who sells it cannot enlighten the inquirer more than to this extent that the article is a *gād* (scum) or a bye-product in the manufacture of some acid. Having subjected the substance to a rough chemical analysis, we came to conclusion that the substance should be nothing more nor less than KHSO_4 , or hydric potassic sulphate, an acid salt and a bye-product, as we know, in the process of manufacturing nitric acid. The reaction of this substance on the copper seems to be this :—



The normal salt di-potassic sulphate, copper sulphate and water are formed.

What takes place in the gold as regards the particles of copper takes place also in the solder used as regards the particles of both zinc and copper that are on the surface.

The oxides of copper and zinc are acted on by the dilute acids of the tamarind or the hydric potassic sulphate as the case may be, and are dissolved away in the form of soluble salts. The reaction in the latter case is :—



As the solder contains a large amount of silver,

its appearance after the copper and zinc have been dissolved away, is almost perfectly white, which appears rather prominent by the side of the bright yellow surface of gold.

The next operation of the *rungwala* is perhaps intended to carry on the operation of cleansing to a further extent. He takes about half a pound of common salt, and mixes it with an equal amount of ordinary potash alum, purchased from the bazar.

The mixture is then reduced to the form of a fine paste. The *rungwala* now covers each of the articles to be coloured with a thin layer of this paste of salt and alum and then places them on the fire. After the paste has dried up it is washed off with water, and generally the colour of the gold appears a little bit improved. The reason of this lies in the fact that the few particles of cupric oxide that remain on the surface are not wholly dissolved out by dilute acid in the first operation are got rid of by this process.

After having been subjected to these two processes, the article acquires almost perfectly the beautiful yellow of pure gold; but as has been stated already the *pān* or solder appears at the same time as white as pure silver. The contrast of these two different colours placed in close con-

tiguity is rather marked ; and the next operation of the *rungwala* is intended to remedy this defect. In order to make the solder and the metal appear of the same colour, he actually covers the surface of the solder with a layer of gold taken from the article itself. This is done in the course of the third process, which we will describe rather fully, as it is the most important of these stages of manipulation at which loss of gold takes place in considerable amount.

Having placed an open earthen vessel on his fire and having put some water in it, the *rungwala* prepares a mixture consisting of, about four parts of nitre (say 1 lb.), one part of common salt and 1 part of alum (say $\frac{1}{2}$ lb each).¹ He then puts the mixture into the vessel, taking care always that the water in the vessel be not more than what is necessary for dissolving about half the amount of salts added. The solution is then heated till it boils evolving large quantities of gases and fumes, amongst which chlorine can be easily detected by its unmistakable corroding odour.

(1) Cf. p. 73 under "killing of mercury and gold," where a mixture, among other ingredients, of alum, common salt and saltpetre technically called a *vista*, is used.

In this boiling solution the goldsmith places the cleansed ornaments so as to keep them wholly immersed. He examines them from time to time and after a while finds that a layer of shining gold has formed on the surface of the white solder. When this deposit is sufficiently thick and the whole article presents the appearance of being formed out of a homogeneous material he takes them out and, washing them well, prepares them for the next operation.

CHEMICAL EXPLANATION

It is difficult to find out exactly the series of chemical reactions that take place during this period. Various impurities in the articles employed make the inquiry doubly complicated. It would, however, do for our purpose to investigate briefly the principal decompositions and formations that occur, and with this view we may suppose the reagents employed to be chemically free from foreign substances.

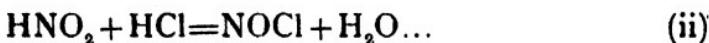
It is well-known that if nitric and hydrochloric acids are brought together, certain reactions take place. If the acids be tolerably concentrated they act upon one another at ordinary temperatures, the mixture becoming yellow and giving off minute

bubbles of gas, smelling like chlorine. If the acids be dilute, we have to heat the mixture to bring about the chemical change. The action that takes place consists of two of stages :—

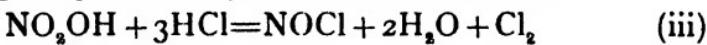
First, the oxygen from the nitric acid oxidizes the hydrogen of the hydrochloric acid, thus :—



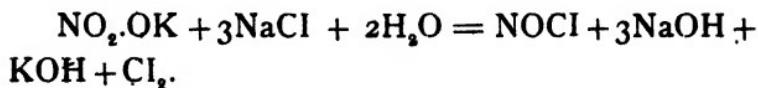
Secondly, the unstable nitrous acid that is formed acts on another molecule of HCl, producing a compound known as nitrosyl chloride and water, thus :—



The reactions (i) and (ii) when expressed by a single equation may be written as follows :—



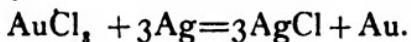
Now, here, instead of free nitric and hydrochloric acids, we have saturated solutions of a nitrate and a chloride, and an action similar to the above may take place under the influence of heat only, instead of water, the hydrates of the metals present in the nitrate and the chloride are formed. Thus, instead of equation (iii) we may have the following action :—



When the solution boils and these actions set

in, the *rungwala* puts the golden articles in it. The chlorine liberated as well as the chlorine in the nytrosyl chloride attacks the gold and reduces it to the form of a soluble chloride, which mixes with the mass of the fluid. The NO of the nytrosyl, which is liberated, is itself a colourless gas, but it rapidly unites with the oxygen of the air and forms the red fumes of nitrogen peroxide which, together with chlorine, are liberated in large quantities during the third stage of colouring.

Now we know that if a solution of gold chloride of sufficient strength is formed and a piece of silver is dipped into it, gold is deposited on the surface of the silver, while a portion of the silver is worn away. The reaction is as follows :—



This reaction takes place in connection with the surface of the solder which is exposed. A layer of gold is formed upon it entirely hiding the white surface, so that to all appearance the whole article seems to be composed of the same material.

In the explanation given above, the use of alum that is added to make up the *jamak* (as the solution employed in the third stage described above is called) has not been shown, and indeed this point we have not been able to clear as satisfactorily as

perhaps it is capable of.¹ It seems to undergo no chemical change, and hence does not act in the capacity of a mordant in this case, as it does so widely in the arts of dyeing or calico printing. It is also found that if no alum is added to the *jamak*, the coating of gold on the solder is produced, but it adheres very lightly to the surface and does not stand such processes as rubbing or brushing. Hence it seems that the only function of the alum is to fix the coating, i. e. to make it adhere firmly to the surface of the solder. Experienced goldsmiths are also of opinion that, but for the alum, the gilding of the *pān* wuld not be permanent. The way in which this is done by the alum is to a certain extent a matter of conjecture. We suppose that the action is of a mere mechanical nature. When the particles of gold stick to the surface of the solder, small quantities of alum solution remain in the pores between the separate particles. These afterwards dry up and crystallise, and the minute crystals act as a sort of mortar

(1) Mr. Chakravarti all along fails to realise the important part which alum plays in yielding sulphuric acid. Moreover in the above equation chlorine cannot be expected to be set free in presence of alkalies; see below under "the Hindu method of manufacturing calomel."

between the particles of gold and the surface of the solder, as well as between the particles themselves.

The third process in the course of colouring is by far the most important source of loss of gold in the whole series of manipulations that the metal has to undergo. We have seen that the losses at all other stages are due to causes of a mere mechanical nature and are necessarily small. In all these cases, the gold escapes the vigilant eye of the worker and hence the extent to which it is lost sight of is minute indeed. Here for the first time the gold undergoes a chemical change—it ceases to exist as gold altogether—and is consequently lost for ever to the illiterate goldsmith.

We should remark that only a very small part of the gold that is dissolved out in the *jamak*—as the solution of nitre, alum and salt used in the third stage described above is called—is re-deposited on the surface of the solder. A large portion of the gold remains in the solution as $\text{AuCl}_3 \cdot \text{NaCl} \cdot 2\text{H}_2\text{O}$. The helpless *rungwala* can do nothing with his valuable fluid but dispose it off for a trifling sum to a class of men called *jamakwalas* who have a crude method of their own to extract some quantity of the gold from the *jamak*. We

shall return to the *jamakwala* subsequently. We must now proceed to the fourth or last stage of colouring, during which the requisite colour is imparted to the metal. The articles, after being extracted from the boiling *jamak* solution, are thoroughly washed and rubbed with a brush, after which another bath is prepared for them. This consists of a solution of tamarind pulp, nitre and common salt in water, which is placed in an earthen pot on fire and heated to ebullition. A little sulphur is then added after which the articles are placed in the liquid. The sulphur is added in a finely divided state, obtained by rubbing a stick of sulphur with a little water on a piece of slate. Care is always taken to add an insufficient amount of sulphur at first, for it is found that the shade of colour that is produced in the gold depends solely on the quantity of this ingredient, which accordingly requires exceedingly carefully regulation. The *rungwala* now examines the colour from time to time, adding more sulphur gradually if he wants the colour to deepen. When the requisite shade of colour is reached, he stops adding the sulphur and keeps on boiling for some time more, after which he takes the articles off the solution and gives them a final wash and polish. If too much

sulphur is added in this operation the colour becomes deep violet and finally black, and the whole process is vitiated. Under the circumstances the *rungwala* has to recommence the work from the very beginning.

It may be noticed that the acid or the commercial hydric potassic sulphate is never used in this stage, as it is used in the first, instead of the tamarind pulp. The reason seems to be that as nitre is also present in the mixture, the addition of KHSO_4 , in the presence of other substances, may result in the formation of nitric acid under the influence of heat.

The chemical actions that take place during the fourth or last stage of colouring seems to be extremely difficult of explanation. There can be little doubt, however, as to the fact that the reddish violet colour is due to the deposition of a thin layer of some compound of gold on the surface of the articles. It is the determination of this compound and of the exact nature of the process by which it is formed that presents all the difficulty.

The fact that the sulphur is one of the most essential things that are required in the production of the colour would seem strongly to suggest at the first glance that the reddish violet tint is due

to the formation of one of the sulphides of gold. It appears that the subject and constitution of the compounds of gold and sulphur is one which has not yet been fully investigated by chemists. But it seems to be a well-established fact that no sulphide of gold is known which is of any other colour than black. This stands in the way of our accepting the hypothesis that the reddish violet colour of gold obtained by the Indian goldsmith is due to the formation of a layer of sulphide on the surface. From the fact that if the colouring is allowed to be overdone *i. e.* if the articles be boiled further after the required tint has been obtained, the gold acquires a deep violet colour, the same conclusion is arrived at.

Accordingly, in spite of the fact that the amount of sulphur added regulates the whole operation of the last stage of colouring, we are constrained to search for the reddish violet colour that is developed in the formation of some other compound than a sulphide. The nature of the colour being the same as would be produced by a thin layer of a violet substance on a yellow surface, it follows that the colour of the compound formed must be violet. And the fact that when the colour is overdone, *i. e.* when a thick layer of the coloured

substance is formed on the surface, the appearance of the metal is dark violet, abundantly confirms the hypothesis. The only compound of gold that possesses this characteristic colour being aurous oxide Au_2O , we are forced to the conclusion that the colour of gold is due to the formation of a thin layer of suboxide on the surface of the metal.

An examination into the nature of the chemical actions that take place during the operation clearly shows that Au_2O is the compound formed. We have seen in investigating the chemical changes during the third stage of colouring that KNO_3 and $NaCl$ being heated together, yield free chlorine together with KOH and $NaOH$. This chlorine after being liberated in the fourth stage attacks the gold and a small amount of auric chloride is formed. But at this point sulphur is added, and the nascent chlorine, instead of going to attack the gold any more, combines with the sulphur to form one or more of the sulphur chlorides. The supply of fresh chlorine being thus cut off, the heated auric chloride decomposes into aurous chloride and chlorine. The chlorine thus liberated combines with the sulphur, while the aurous chloride is acted on by the KOH and $NaOH$ with the result that Au_2O is

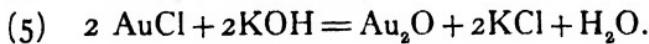
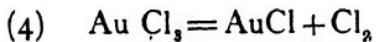
formed.¹ This is partly deposited on the surface of the gold producing the required colour and partly mixed with the saline solid matter present in the solution.

The series of chemical reactions may be expressed by formula as follows :—

(1) $\text{KNO}_3 + 3\text{NaCl} + 2\text{H}_2\text{O} = \text{NOCl} + 3\text{NaOH} + \text{KOH} + \text{Cl}_2$; this reaction itself consists of two stages as explained before.



(3) $2\text{Cl} + \text{S}_2 = \text{S}_2\text{Cl}_2$ (SCl_2 may also be formed in the presence of excess of nascent chlorine).



It will be observed from the above formula that the addition of sulphur is indispensable in this operation. If the excess of chlorine were not removed by sulphur, as is done in (3) above, the gold would continue to be dissolved out and a large loss of the metal would arise as in the course of the third stage.

Moreover, with a free supply of chlorine, the auric chloride would never be reduced to aurous chlo-

(1) The explanation is scarcely satisfactory; it may be taken for what it is worth.

ride, and thus no formation of aurous oxide could take place. It is thus seen that, though the sulphur used is not directly contained in the compound which gives the colour, it regulates the whole reaction in the most important stages of its progress.

The above hypothesis is supported by the fact that if a little sulphur is added to the fluid obtained in the fourth stage of colouring, it will be found to dissolve in the fluid. This could not be the case unless a compound like S_2Cl_6 , which can hold sulphur in solution, were formed during the re-action.

It has been mentioned above that the loss during the third operation of colouring is considerable. Indeed, from the records of observation given at the end of this section, it is clear that the loss is not only large, but that its extent is also uncertain in the extreme. In some cases it is as low as half a pie per tola, while in others it reaches the ruinous figure of six pies per tola, or nearly one tenth of the whole weight. The average amount of $2\frac{1}{2}$ pies per tola, which is obtained from our figures, is not very different from the idea of experienced *rungwalas* and goldsmiths on the subject. The largeness and uncertainty of loss are easily accounted for by the ever-varying constitution of the bazar articles used in the operation, some of

them being very nearly pure, while others contain as much as 25 to 30 per cent of impurities, as well as by the want of any accurate precision as regards the proportion of materials employed. The ingredients are seldom weighed before being mixed together; and the varying amount of water present physically in the salts is an additional source of error and confusion in settling the proportion by mere inspection of bulk.

The following figures will give some idea as to the magnitude of the loss in colouring :—

Weight before colouring.			Weight after colouring.			Loss.
Tolas.	Annas.	Pies.	Tolas.	Annas.	Pies.	Pies.
6	10	0	6	7	1'5	10'5
3	2	0	2	14	1	15
12	12	1	12	5	3	26
5	3	2	5	2	0	6
3	0	2	2	12	0	18

THE RESTORATIVE PROCESSES

Having in the previous paragraphs described with tolerable fulness the various sources of loss of gold in the course of its artistic manipulation by the Indian goldsmith and having in each case pointed out the form in which the metal escapes the hold of the worker, we will now turn our eyes to the meth-

ods which now obtain in our country for recovering, as far as possible, the amount of material which is lost. It is perhaps worth while here to point out that to re-obtain the entire amount of lost material is absolutely impossible from the innate property of the extreme divisibility of matter; and our sole object in these restorative operations should be to secure the recovering of the largest amount of metal that can possibly be saved. There are two small classes of men in Bengal who obtain their living by extracting gold from the refuse and bye-products of the goldsmith's workshop. These are the *neharwala* and the *jamakwala* before alluded to. These classes of men are found to cluster in the suburbs of large towns and important centres of jewelry manufactures. In the smaller towns and more insignificant villages, the bye-products have either to be thrown away or to be disposed of in the best manner that the goldsmith can hit upon. Not unfrequently in such cases the goldsmith himself undertakes to play the part of a *jamakwala* and *neharwala* to the best of his abilities. But the unpractised manipulation of processes, which are themselves far from being satisfactory is sure to result always in the loss of a large portion of gold.

We will now proceed to describe the operations

of the *neharwala* and the *jamakwala*. It may, however, be marked here that the immense difficulty in the way of obtaining the slightest information regarding the indigenous methods adopted by these workmen, in the exercise of their profession, can hardly be appreciated by one who has not personally made an attempt to penetrate into the mysteries of any of the trade or manufacturing secrets of India. The unfortunate stagnation of almost all departments of knowledge, art and industry in India that perplexes and mortifies an inquirer, owes its origin to a longstanding and universal spirit of conservatism inherent in our people which, however eloquently defended by orthodox advocates of caste, is manifestly one of the principal causes why the Indian craftsman lags so far behind in the modern race of nations. The healthy broadness of views, resulting from the dissemination of liberal English ideas among the masses, has, indeed, broken some of the most pernicious strongholds of the intellectual monopolies of India ; but there are classes of men who still in obscure nooks of society keep to themselves what they regard as the treasures of professional secrets but what, after all, may be mere child's play to the eyes of the scientific world.

To our enquiries about the nature of the *neharwala* and the *jamakwala* the deafest ears were turned. Our attempts to impress upon these people the necessity of the application of chemistry to improve their methods were mere cries in the wilderness. And it was not until we had spent several weeks in constant intercourse with these people that we could begin to collect the information necessary for such an inquiry. Bit by bit we gained from different sources some knowledge of the processes which are given below in a continuous and well-arranged form.

THE NEHARWALA

Now and then the *neharwala* makes his appearance in the goldsmith's workshop, in order to obtain the collected sweepings and other refuse of the rooms. The interval of time varies from one to three months according to the nature of the work that carried on in the rooms as well as to the amount of gold that is manufactured into ornaments. It is useful to state here that every day before work is commenced, the room is swept very clean and the sweepings, instead of being thrown away, are carefully stored up in a corner.

The heap of dust and rubbish thus accumulated from day to day is the chief object of the visit of the *neharwala*. Having inquired as to the amount of gold that has undergone manipulation since the last disposal of sweepings or *nehar* (from this the *neharwala* gets his name) as well as the nature of the articles that were manufactured, he proceeds to settle the price which depends chiefly on these conditions. The *nehar* of twenty tolas of good gold manufactured into articles, which required drawing, beating as well as soldering would generally be disposed of for a single rupee. It may be interesting to observe that a goldsmith, however dishonest in other respects, would never deceive a *neharwala* by selling to him a heap of ordinary rubbish for fear of losing credit and custom in the department of *nehar-selling*.

The next thing that the *neharwala* wants to obtain is the heap of rejected crucibles.

It has been stated before that indigenous crucibles cannot be employed more than once for melting purposes, and hence the number of waste crucibles is not small in our goldsmith's workshop. The nature of the crucibles and the amount of metal melted in each, together with the qualities of the gold, settle the price. We have seen a score of

crucibles of average size selling for eight annas.

If the goldsmith's shop is large, the soot hanging from the ceiling and walls is also purchased.

The last thing that the *neharwala* asks the shopkeeper is whether that day he would give a *taljhar*, by which is meant if he would allow the workmen's mats to be removed and shaken and the space below the mats swept. This operation is ordinarily performed once a year. The sweepings thus obtained are again valued. And after paying the prices the *neharwala* returns home with his heavy load, which sometimes reaches the respectable weight of 50 or 60 pounds.

The first thing that the *neharwala* does with his materials is to crush them fine. This is only necessary when earthen lumps of large size are formed and mixed up with the *nehar* in considerable numbers and is dispensed with in most cases where the large pieces are few in number and can be picked up and thrown away.

The second process is to throw the crushed materials into a big earthen pot in which the *nehar* remains immersed in water for a certain number of days, depending on the quality and quantity of the *nehar*. The object of this is to reduce fragments of clay to a fine state of division by which particles

of gold that might otherwise remain imbedded inside the mass of earthy lumps are at once exposed to view.

The next and the main operation is that of working. The thoroughly soaked *nehar* is put in large earthen vessels and more water is added if necessary. The mass is then thoroughly stirred and the lighter earthy material which yet floats when the heavy metallic matter has settled in the bottom, is taken off. By the repetition of this process the solid matter is reduced to a very small bulk. It is then allowed to settle and the water is slowly poured off. The moisture that yet remains is dried up either on fire or in the sun.

When several *nehars* have been separately washed in the preceding way, the remnants of all the washings are mixed together and the mixture is washed once again. This operation is exactly like the preceding but is carried on more carefully and in better vessels. When it has been completed, about one-quarter of the mixture may be perceived to consist of metallic substances.

Among the metals present in this mixture, iron is often found and, as its presence is extremely undesirable when the materials are placed on the crucible for melting, it is generally got rid of at this

stage. Formerly this was done by picking up the separate bits of iron by fine pincers, but now-a-days the magnet is almost universally used for the purpose.

The next process is that of melting. This is carried on in the ordinary way, care being taken to procure a crucible big enough for the purpose. The earthy matter sticks to the sides of the crucible, while the metallic portion melts and falls to the bottom. A mixture of gold, silver, copper and zinc is thus obtained.

The old method of obtaining pure gold from such a mixture as this is said to have been as curious and interesting as certainly it was laborious and protracted. The alloy was first of all beaten into leaves of extreme thinness, about 5 inches square in size. Each leaf was then covered with a thin layer of a paste of brick dust and common salt. The leaves were finally arranged one above another and exposed to the heat of fire. After a certain number of days, depending on the nature of the alloy and the temperature of the fire, the gold was found to be very nearly pure.

This method has now, however, been entirely superseded by the far easier and more economical process of treating the alloy with strong nitric acid.

For this purpose, however, the metal must be obtained in a fine state of division. This is done rather ingeniously by melting the material and, while molten, by suddenly dropping it in water. By this means the metal is at once reduced to a fine powder without the expenditure of any manual labour in the way of hammering. Care, however, should always be taken to see that the vessel of water in which the molten metal is dropped has a wide mouth. On one occasion, at which we were present, the liquid metal was poured into a narrow-mouthed vessel, and the steam suddenly generated was so great and powerful as to very nearly cause an explosion.

The extraction of gold from rejected crucibles is done much in the same fashion. These are pulverised and treated in the same way as ordinary *nehar*. Sometimes the powders of crucibles are mixed up with the common *nehar* to avoid the necessity of a separate series of operations, but more frequently the smallness of their bulk induces the *neharwala* to treat them separately.

THE JAMAKWALA

We will now turn our attention to the methods of the *jamakwala*. He periodically visits the work-

shops of his patron, the *rungwala* from whom he obtains the necessary amount of *jamak* on the payment of a price which depends on the quality and the quantity of gold that has been coloured, as well as the loss of weight that has taken place in the articles during their make. To give an approximate idea of the commercial value of *jamak* it may suffice to state that we once purchased a *jamak* of 20 tolas of sovereign gold (which is 22 carats or 916·66 per mille fine) for one rupee only. We may also observe that the demand of *jamak* is not at present at par with the amount of its supply; and at some of the bigger *rungwala's* working-rooms, one may see big earthen jars full of this substance, collected and stored up for want of purchasers. It may be interesting to add that even in this obscure department of business, the evil genius of man has set to work, and one has to be careful in dealing with a *jamakwala*, if one is a new hand in these affairs.¹ On one occasion we happened to be defrauded and were given a substance as a *jamak* of 35 tolas of gold for what

(1) It may be observed, however, that a *rungwala* would never deceive a *jamakwala* in the same way as he would deceive a stranger for fear of losing credit and custom in the department of *jamak*-selling.

we considered the modest price of Rs. 2. But the thing turned out to be an imitation *jamak* only and all our best efforts could not discover in it the slightest trace of gold.

Having obtained a sufficient amount of this fluid the *jamakwala* returns home. His first step is to get rid of the fluid part of the *jamak* by boiling it. For this purpose he has got large earthen vessels with wide mouths which can be placed over a fire. When almost the whole amount of water has been evaporated off, he pours out the viscous mass into an open eathern vessel and porceeds to what we shall call the second process of the *jamakwala*.

With the solid matter of the *jamak* obtained by the first operation, the *jamakwala* mixes a small quantity of borax as well as a large amount of a substance known as *poonoor*. The weight of powdered *poonoor* that is thus added is about four times the weight of the *jamak* matter. Having thoroughly mixed these substances with such an amount of cow-dung as is required to give consistency to the material, he forms them into balls of about two or three inches in diameter. He then dries these balls and when perfectly dried they are ready for the third process.

The *poonoon* employed in the above process is a hard quasimetallic substance that can be purchased from certain grocers at the rate of three or four seers per rupee. It is, they say, nothing but a bye-product in the operation of *rupā-pākāno* by which is meant the operation of chemically purifying silver which has been alloyed with a large amount of copper and other metals. The usual method of conducting this operation in our country is to mix up the alloy with a large amount of lead and after melting the whole mass to blow air from above. [This operation, as also the next one, is practically that of cupellation]. The pure silver, it is found, separates in the course of the operation and collects at the bottom, while the partially oxidised lead, together with the impurities which existed originally in the silver constitutes the *poonoon* of trade. We analysed qualitatively a sample of ordinary bazar *poonoon* by the wet way after dissolving it in nitric acid and found it to contain lead, copper and zinc with traces of silver and iron.

The third process of the *jamakwala* is the main step in the reduction of gold. He scoops out on the earth in an open place a hollow of the shape of a hemisphere about a foot in diameter, and having thoroughly smoothed the interior of this hollow, he

covers it with a layer of slaked lime about half an inch thick. After the lime has dried, it presents the appearance of a coarse white china vessel, imbedded in the earth. In this the balls prepared by the second process are placed. The *jamak-wala* then forms a powerful charcoal fire over it and with two or three large pairs of bellows causes the flame to play on the mass below. The lead of the *poonoor* is soon reduced and dissolves, as it were, the reduced gold, silver and copper. A large metallic mass thus collects at the bottom of the hollow, consisting mainly of lead. The blowing is now continued as hard as possible from above and the metal being oxidised to litharge begins to be blown off. The process must be continued till the whole of the lead has passed off and a mixture of gold, silver and copper remains behind. Care should always be taken in this operation to see that the last trace of lead is thoroughly got rid of; for nothing affects so much the ductility and malleability—virtues most important for the purposes of the goldsmith—of gold as a mixture ever so little of lead. Thus “one two-thousandth part renders the metal too brittle for rolling and its very fumes produce a serious effect upon it.”¹

(1) Maunder's Treasury of Science, Article : Gold.

Such is the tedious length and such the laborious and complicated nature of the processes by which the *neharwala* and the *jamakwala* extract precious metal from the large heaps of rejected sweepings and dirt and bye-products of the goldsmith's workshop. But their labours have only the empirical experience of years to guide them and not the acuteness of a well trained scientific mind ; and accordingly we find that a large portion of their work is directed to achieve in a laborious and round-about way an object which a slight knowledge of chemistry enables us to secure in the simplest manner imaginable.

With a view to shorten the labours of the *jamakwala* as far as possible, we began a series of experiments, investigating the properties of the *jamak* and trying to find out the easiest mode of extracting gold therefrom. As the results of our experiments we have found that, working on ordinary plans in the wet way, we can recover an amount of gold, which is equal to, if not in all cases greater than, the quantity which the *jamkawala* can obtain by his expensive and protracted methods.

We need scarcely give the properties and the constituents of the various specimens of *jamak*

which we obtained from the bazar from time to time for experimental purposes. The way in which a *jamak* is formed having been before described in full, the results of analyses will be nothing but tedious. It will be sufficient to observe that in all cases the *jamak* was a clear greenish-yellow liquid of rather thick consistency with a large mass of grey solid matter at the bottom consisting almost wholly of soluble saline matter.

It may be also added that among bases, silver, copper, zinc, gold, aluminium, potassium and sodium were the principal ones that were found; while amongst the acids present, nitric, sulphuric and hydrochloric were recognised in large quantities. Traces of free chlorine could also be found in some of the solution, while perceptible amounts of iron were found in almost all.

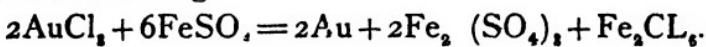
The microscopic appearance of *jamak* may be interesting as showing the exact state in which gold exists in the solution. With this view we examined under a microscope (magnifying 375 times) a drop of a clear solution of *jamak* as well as an amount of the solid saline matter lying at the bottom. The appearance, in both cases was the same, only in the latter the crystals were more numerous and closer together. The octahedra

of alum with occasional facets of cubes, the long furrowed and rhombic prisms of nitre and the cubes of common salt were very prominent. Between these, in numbers far less, could be discovered long, transparent needles. These were most probably crystals of double chloride of gold and sodium which is invariably formed when a solution of auric chloride is mixed with chloride of sodium. The constitution of this substance is $\text{AuCl}_4 \cdot \text{NaCl} + 2\text{H}_2\text{O}$, and it is the commercial "non-deliquescent chloride of gold" which is ordinarily sold in one gramme tubes.

Besides the above crystals, we frequently found amorphous particles, wholly or partially opaque. Those that did not transmit light at all were probably particles of dust or other earthy matter which were present in the ingredients in the shape of impurities. But there were others which transmitted a beautiful green light and these were likely to be fine particles of gold. As these were rather few in number, it might be inferred that in the *jamak*, gold existed chiefly in combination. It is also probable that the greatest part exists as $\text{NaAuCl}_4 + 2\text{H}_2\text{O}$.

From a liquid containing such a variety of substances in solution as the *jamak* does, it is no doubt a difficult task to precipitate the gold which is present perhaps in the minutest quantity of all.

The reducing agents that are mentioned by chemists as suited for reducing gold from solutions are exceedingly numerous. Of those that are practically employed, the principal ones are ferrous sulphate, oxalic acid, sulphurous acid metallic iron. We tried each of these in a large number of cases and found that ferrous sulphate gives the best result of all. The reaction that takes place during reduction by ferrous sulphate is something like the following :—



The gold is precipitated as a fine, heavy, black powder and easily settles at the bottom.

At first we used the pure material obtained from the chemists for precipitating *jamak*; but afterwards found that the crude article of the bazar, after being dissolved in water and filtered, yields a solution which serves equally well.

This makes the process a matter of very little expense and with an anna worth of good crystals of *hirakash* (the Bengali name of ferrous sulphate), a *jamak* containing 8 annas weight (for about Rs. 14 worth) of gold can be satisfactorily extracted.

We are far from thinking that in our experimental attempts to extract gold, we were able to catch the whole of the material that was present

in the solution. It is very probable that in the fine state of division, in which the precipitation takes place, a considerable amount of the metal is washed away in the process of collection. But this loss is due to causes of a mere physical nature and can be prevented to a large extent by the use of better and more refined instruments.

It has, however, been ascertained that even with rough instruments the easy and inexpensive mode of wet working gives as good results as the laborious and costly method of the *jamakwala*. The indigenous worker thinks himself fortunate if the amount of gold which he extracts is of twice the value of the *jamak* from which it is obtained, and we are convinced from the results of repeated experiments, that the wet method promises in general no less than twice the amount of profit with the advantage of saving time, labour and expense.

CONCLUSION

The importance of the subject that has been described and discussed in the major portion of the preceding pages is far greater than it appears to be at the outset. Month after month, in Calcutta and in the larger towns of Bengal, considerable quantities of gold undergo transforma-

tion under the goldsmith's hammer; and as every article so manufactured is coloured before being used, the amount of *jamak* that is produced must be large indeed. By a rough calculation we have estimated that about 3500 persons earn their bread in Calcutta by following the occupation of a manufacturing Jeweller; and allowing for holidays, illness and want of work it may be safely held that about 2,000 hammers ply on an average every day on gold and silver within the boundaries of Calcutta and its suburbs. Out of these 2,000 hands 1,500 may be supposed to work on the more precious metal of gold alone. On the modest calculation that a man works one-half of a tola of gold in the course of a day, 750 tolas of golden articles are turned out every day in the metropolis. Supposing as we have pointed out before that in colouring only one-half of an anna of weight of gold is dissolved out into the *jamak* per tola, as much as 375 annas or more than 23 tolas of gold are every day dissolved in Calcutta alone. As has been shown before, we have ample reasons to believe that the *jamakwala* can seldom get out as much as one-half the amount of gold that exists in the *jamak* by his crude and imperfect methods. Granting, however, that he can reclaim

so much as two-thirds of the gold lost in colouring, we are still forced to the astonishing conclusion that seven tolas of gold are absolutely lost in the town of Calcutta alone with the lapse of each day.

There can be little doubt that if the whole of the *jamak* that is now thrown away or otherwise washed could be collected and worked on the lines suggested by the newest and the most refined chemical methods, no less than three fourths of the entire loss could be reclaimed. This would amount to some thing like 15 or 16 lakhs of rupees per annum in these hard days of struggle for existence.

This is not the place for giving even the outlines of any elaborate scheme by which the collection of *jamak* and the extraction of gold therefrom may be carried out in practice on an extensive scale.

Business may be commenced at once by setting up a laboratory fitted up for the purpose after the latest fashion, at a convenient station in the centre of the Province and by purchasing the *jamak* that has already accumulated in the hands of the *rungwala*. In the meanwhile agencies may be established in every district for the purchase and storage of *jamak*. When the accumulated

jamak is all exhausted, these agencies will be able to feed the laboratory continually by the supply of fresh *jamak* from time to time, from all parts of the country.

NOTE ON THE SALTS.¹

Romaka, also called Sākambarī, is the salt produced from the Sambar Lake near Ajmere (Dutt).²

Sauvarchala : see under saltpetre.

Audbhida (lit. begot of the soil) is the name applied to the saline deposit commonly known as the *reh* efflorescence. It consists "chiefly of sodium chloride and sulphate in varying proportions. In addition there are sometimes carbonate of soda, and we have usually found some magnesian sulphate. In certain localities the last named salt is in very considerable proportion. In other cases nitrate of lime or alkali is present."

"The efflorescences thus produced consist of three groups; 1st, the neutral, which contain no carbonate of soda (these consist chiefly of sodium chloride and sulphate, and frequently magnesium sulphate); 2nd, the alkaline chlorides and sulphates, but no lime or magnesian salt; 3rd, the nitrous efflorescences."—Dr. Center's Note on

Reh quoted in Watt's Dictionary of the "Economic Products of India". Vol. VI. Part I. pp. 410-417.

We have thus a ready explanation of the conversion of mercury and other metals into their chlorides when they were heated in combination with audvida and other salts (see p. 48). The magnesium sulphate would readily yield sulphuric acid, which with sodium chloride and nitre, might be expected to produce aqua regia ; (for further information see under "rasakarpura" or the chlorides of mercury).

Vida or Vit is at present taken to be the same substance as the kálánimak or "black salt"; it is difficult to ascertain what it stood for at the time of the Charaka and the Susruta. The following account is given in Watt's Dictionary of the Economic Products of India. "BLACK SALT is prepared in upper India chiefly at Bhewani in the Hissar district by heating together in a large earthen pot 82lb of common salt, one pound of the fruit of *Terminalia chebula*, and one pound of *Phyllanthus emblica*, and one pound of sajji (impure carbonate of soda), until by fusion of the salt the ingredients are well mixed, when the pot is removed from the fire and its contents allowed to cool and form a hard cellular mass. This prepa-

ration is used medicinally principally as a digestive." The salt has a reddish brown colour and consists mainly of sodium chloride with traces of sodium sulphate, alumina, magnesia, ferric oxide and sulphide of iron. Most of the samples, we have examined, were found to evolve minute quantities of sulphuretted hydrogen when treated with an acid; even when placed in the mouth the *taste* of this gas was distinctly felt. It is very probable that when the saline mass is fused with the organic matter [T. chebula], a portion of the sodium sulphate is reduced to sulphide, which by double decomposition converts the traces of iron salt present into the sulphide. The sulphide was detected both in the insoluble residue (as FeS) as well as in the aqueous extract.

In the Chemistry of Bubacar, the following salts are mentioned :—

La *classe des sels* renferme onze espèces : le sel commun, que l'on mange, le sel pur, le sel amer, employé par les orfèvres, le sel rouge¹, le sel de naphte² le sel gemme proprement dit, le sel indien³, le sel alcalin,⁴, le sel d'urine, le sel de

-
- (1) Sel gemme coloré.
 - (2) Sel gemme bitumineux.
 - (3) Salpêtre?
 - (4) Carbonate de soude.

cendres¹, le sel de chaux². (La Chimie au moyen âge, T. I. p. 308).

It will be seen, however, that the last 3 or 4 products are in Hindu Chemistry very properly placed under the kshāras or the alkalies (p. 45).

NOTE ON THE KILLING OF METALS

From the time of the Charaka and the Susruta we find metallic preparations in the shape of oxides, sulphides and sometimes chlorides recommended for internal administration. The various formulas, which will be found scattered throughout above, give us methods for *killing* the metals.³ But a *killed* metal is not necessarily a compound; it sometimes means a metal deprived of its well characterised physical properties, e.g. colour, lustre &c. Thus the Ayurvedic *killed* gold and silver often represent the respective metals, in a fine state of division. Take for instance the following recipe from "Rasaratnākara" by Nityanātha :— "Rub gold leaf with 4 times its weight of *killed*

(1) Carbonate de potasse.

(2) Potasse caustique impure.

(3) See pp 30-31, 48 72-73.

mercury (*i. e.* sulphide of mercury) and sublime the mixture in a closed crucible. On repeating the process 8 times, the gold is killed." (Cf. also the processes described in pp. 105-106). In the preparation of "makaradvaja" (p. 132, note) the gold, which is left behind, would be regarded in the same light. As the Hindu Iatro-chemists were very particular about the *killing* of the metals being ensured, they had often to hit upon proper tests for securing this purpose. Thus "Rasaratnā-kara" says:—"In order to examine whether the mercury has been completely reduced to ashes, it has to be heated over a gentle fire for 3 hours. If the weight remains constant, know then that it has been completely killed." In other words it means that if there be any free mercury present, it would volatilise off and thus there would be a loss in weight. In page 118 will also be found some tests for *killed* iron. The language of a portion of couplets 25-28 is somewhat obscure and the meaning seems to be the very reverse of what the context would suggest; "*killed iron is that which, on being mixed with treacle.....honey and heated, does not revert to the natural state.*" By "natural state" the author probably conveys the state in which it originally was.

i.e. of an oxide, as immediately below he figuratively speaks of the *resurrection of the dead* (p. 120). Indeed, the ideas of the alchemists of the East and the West ran so closely on parallel lines that the best commentary we can offer to the above is the following extract from Hoefer's work, describing the notions current among the old Egyptinas.

“*Expérience.* On brûle, on calcine du plomb ou tout autre métal (excepté l'or et l'argent) au contact de l'air. Le métal perd aussitôt ses propriétés caractéristiques, et se transforme en une substance pulvérulente, en une espèce de cendre ou de chaux. En reprenant ces cendres, qui sont, comme on disait, le résultat de la *mort du métal*, et en les chauffant dans un creuset avec des grains de froment, on voit bientôt le métal renaître de ses cendres, et reprendre sa forme et ses propriétés premières.

“*Conclusion* :—Le métal, que le feu détruit, est *revivifié*¹ par les grains de froment et par l'action de la chaleur. (T. 1. p. 228).

“N'est-ce pas là opérer le miracle de la résurrection?”

T. 1. p. 228

(1) Les mots *revivifier*, *rivivification* sont encore aujourd'hui employés comme synonymes, de *réduction de désoxydation*.

Other "experiences" as well as technical terms have also their exact analogues in the language of the Western alchemists. Thus side by side with the "tests for killed mercury" (p. 74) and the "process for the fixation of mercury" (p. 131) we may quote:

"Viennent ensuite toutes sortes de recettes pour la "combustion" de l'argent, de l'or, du cuivre de l'étain, etc., faisant parfois double emploi avec le le livre II. Rappelons ici que le mot *combustion* signifiait la calcination des métaux en présence de diverses matières spécialement le soufre, le mercure, les sulfures métalliques, etc. Les produits en étaient dès lors fort multiples.—"La Chimie au moyen âge", 1. p. 309.

"La calcination du mercure était appelée à cette époque coagulation ou fixation du métal" *Ibid.* p. 154.

The passage in *Rasārnava* describing the efficacy of the apparatus especially the line "without the use of herbs and drugs mercury can be killed with the aid of an apparatus alone" (p. 67.) is highly significant. It refers no doubt to the formation of the red oxide of mercury, the precipitate *per se*. Cf. "Il s'agit de la fabrication de l'oxyde de

mercure préparé *per se*, c'est-à-dire sans addition d'aucun corps étranger." *Ibid*, p. 154

ON THE HINDU METHOD OF MANUFACTURING
CALOMEL; THE HINDU AND JAPANESE
METHODS COMPARED—THE EXPLA-
NATION OF THE REACTIONS INVOLVED

According to the Hindu alchemists, there are four kinds of the ash (*bhasma*) of mercury, namely black (*kajjali*, p. 61), red (*vemilion*), white and yellow.¹ The white variety is often spoken of as *rasakapūra* or camphor of mercury; it is often found to be almost pure calomel and sometimes a mixture in indefinite proportions of calomel and corrosive sublimate.

The chlorides of mercury are found to be medicinally used from the 12th century downwards and various recipes are given for their preparation. The earliest account seems to occur in *Rasārṇava* (ch. XI. 24), where we find a mixture among other drugs of green vitriol, alum and salt, described as

(1) लालभस्मा, रक्तभस्मा or रसचिन्दूरः ; श्वेतभस्मा and पीतभस्मा

Vide—रसेन्द्रसारसंग्रहः what the yellow ash refers to is not easy to make out.

capable of "killing mercury in an instant" (see p. 73). A more detailed description is found in "Rasendrachintāmani" a work which may safely be placed in the 13th-14th century. Says the author Dhundhukanātha : "I am now going to explain the process of preparing rasakarpūra, which is a remedy for all diseases: take a strong earthen pot and fill one-fourth of it with common salt and place over it a mixture of brick-dust, alum and rock-salt. Rub mercury with the juice of Indian aloe and an equal weight of the above mixture into a paste; deposit it in the earthen pot and cover it with the same ingredients. The pot is to be firmly closed with a well-fitting lid. Now apply heat for three days together."¹

(1) सर्वरोगहरी कार्यप्रक्रिया

स्थात्वा दृढ़घटितायामर्जुं परिपूर्य्य तथ्यक्षवणांशैः ।

रक्षेष्टकारजोभिस्तदुपरि दृतम् तुर्यांगम् ॥

सितसैख्यवं निधाय खटिकारों तत्प्रसंच तस्मोर्जुं ।

खटिकारिधवलसैख्ययुज्जरसैः कन्याम् परिष्ठैः ॥

जल्वा पर्पटसुचितं तदुपर्याधाय तददेव पुणः ।

खटिकारिसैख्यरजो दद्यादितः खलतो रसस्य ॥

लाभाय तदुपरि पर्परखल्लान् धूत्वा परया ।

हृदस्यात्माकाय सुद्रयित्वा दद्यसनितयं विपचिद्विधिना ॥

Another work of the Iatro-chemical period, "Rasendrasārasamgraha" describes the following process for obtaining the *svetabhasma* or white ash. "Rub mercury repeatedly with pāmsu salt (*i. e.* audbhida salt : see p. 243) and the juice of *Euphorbia neriifolia*; place the mixture inside an iron bottle, the mouth of which is closed with a piece of chalk. The bottle is embedded in a mass of salt (cf. the salt-bath, p. 123) and then fire is urged for an entire day. The white deposit in the neck of the bottle is to be collected."¹

The Bhāvaprakāsa written about 1500 A. D. prescribes calomel in the treatment of *Phirangaroga* (lit. the disease of the Portuguese *i. e.* syphilis) and gives the following recipe: "Take of purified mercury, *gairika* (red-ochre), brick-dust, chalk, alum, rock-salt, earth from ant-hill, *kshāri lavana* (impure sulphate of soda) and *bhāndaranjika* or red earth used in colouring pots in equal parts, rub together and strain through cloth. Place the mix-

१) पिण्डं पांशुपटु भगादमस्तं वज्राम्बुगा नेकाशः

नूत आतुगतं खटीकवस्तिं त सपुटे रोषयेत् ।

अमलाहावस्थ तस्य च तस्मि प्रज्वास्य वक्षिं हठं

चक्षं याज्ञामधीन्दुकन्दवस्तं भक्षीपरिस्तं श्रगेः ॥

true in an earthen pot, cover it with another pot, face to face, lute the two together with layers of clay and cloth. The pots so luted are then placed on fire, and heated for four days, after which they are opened, and the white camphor-like deposit in the upper part is collected for use." 1

(1) युहमृतसमं कर्यात् व्येकं गैरिकं सुधीः ।
 इष्टिका खटिका तश्तस्फटिका सिम्बुलकम् च ॥
 वस्त्रीकं चारत्वर्णं भाष्टरज्ञकवृत्तिकाम् ।
 सर्वाण्येतानि सचूर्यं वाससा चापि शोधयेत् ॥
 एभिशूर्येत् मृतं यावद्यामं विमर्शयेत् ।
 तच्छूर्णसाहतं मृतं स्थालीमध्ये परिचिपेत् ॥
 तस्माः स्थाल्या सुखे स्थालीमपरां धारयेत्समाम् ।
 सवस्त्रकुहितमृदा सुद्रयेदनयोमुखम् ॥
 संशीष्यं सुद्रयेत्त्वयीभूयः संशीष्यं सुद्रयेत् ।
 सव्यग्विशीष्यं सुद्रां तां स्थालीं चुल्यां विधारयेत् ॥
 अर्घ्यं निरक्तरं दद्याद्यावद्विगचतुष्यम् ।
 अहारीपरि तदृशनं रक्षेद्यवादहर्निश्चम् ॥
 अनेकहाटयेद्यत्तमूर्हस्यालीगतं रसम् ।
 कर्पूरवस्तुविमलं गृहीयाद्ववत्तरम् ॥

The Japanese method has been described by Professor Divers at length¹ and a summary of it is given below in the eminent chemist's own words :—

"The Japanese prepare calomel pure, above all things from corrosive sublimate. They heat balls of porous earth and salt soaked in bittern along with mercury, in iron pots lined with earth. The heat forms hydrochloric acid from the magnesium chloride in the bittern, and the mercury sublimes into the close-fitting but unattached clay covers of the pots. Air enters by diffusion and oxygen and hydrochloric acid gas act together in the hollow cover on the vapour given off from the sublimate of mercury there formed."

It will be seen that the process somewhat approaches that of "Rasendrasārasamgraha" in which the pāmsu salt, which contains magnesium sulphate (see p. 252) sets free hydrochloric acid. The recipe of "Rasendrachintāmani" and Bhāvaprakāsa would seem to have their analogue in the Chinese method, for a short account of which we are also indebted to Professor Divers' Memoir :—

The translation from "Bhāvaprakāsa" as given above is by Dutt.

(1) "Journ. Sec., Chem. Ind." Vol XIII. (1894) pp. 108-11.

"The Chinese process, if correctly described, differs from that used in Japan in several material points, one of which is that the mercury is intimately ground up with the other materials, and one fails to see what reaction can take place between it and the two others, namely salt and alum. Heated, the mixture must give off mercury and hydrochloric acid, and then these, as in the Japanese process, will with air give the calomel, but this is independent of the previous intimate mixture of the mercury with the salt and the alum. Another point is that in place of the magnesium chloride of sea-water as the source of hydrochloric acid, the Chinese are said to use alum or copperas, which, with the salt, will react to give hydrochloric acid. A third point is that the cover is said to be closely luted to the iron pot, which must nearly exclude the air, without which it is impossible to explain the formation of calomel. Perhaps this is the reason why the Chinese process is said to take four or five hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting, it will also account for the fact, if it is one, that the yield of calomel is markedly less in weight than the mercury used."

The Chinese and Hindu methods¹ are essentially the same as in both alum plays an important part in that it yields sulphuric acid. Professor Divers in his explanation of the Japanese method supports the view that the hydrochloric acid at first liberated undergoes *aerial oxidation*, thus : $2\text{HCl} + \text{O} = \text{H}_2\text{O} + \text{Cl}_2$; and it is the chlorine thus set free, which attacks the mercury, forming calomel—a view which has been accepted by no less an authority than Mendeléeff.² The author has all along entertained doubts as to the correctness of Divers' hypothesis and he has, in his lectures, pointed out to his students that some "catalytic agent" as in Deacon's process must account for the reaction involved. This now turns out to be so. It is the *ferric*

(1) To which may be added that of the Latin Geber :—

"Argentum vivum sic sublima. Sume de eq libram unam, vitrioli rubificati libras duas, aluminis rochae calcinati libram unam, et salis communis libram semis, et salis petrae quartam partem, et incorporatum sublima, et collige album, densum, clarum et ponderosum, quod circa vasis sponditia inventum fuerit, et serva, ut tibi de aliis scripsimus. Sed si in prima sublimatione inventum fuerit, turbidum vel immundum, quod tibi accidere poterit propter tuam neglegentiam, illud cum eisdem fecibus noveris iterum sublimare, et serva."—"Ges. d. Chem." IV. p. 189.

2) "Principles of Chemistry," Vol. II. p. 54 (Eng. trans. ed. 1897).

oxide, a constituent of the burnt earth "*mitsuchi*"¹ which really acts as the chlorinating agent, if we may so call it, in that it combines with the hydrochloric acid forming ferric chloride, and the latter in turn dissociates into *ferrous chloride* and *free chlorine*.

The alumina of the clay also plays a similar part. A series of experiments were undertaken to establish this point, the results of which are stated below:—

I. Mercury, intimately rubbed with moist magnesium chloride, was gently heated in a combustion tube in a current of carbonic acid gas: globules of mercury and hydrochloric acid condensed in the cooler parts of the tube, but no calomel was formed.

II. Mercury, intimately mixed with magnesium chloride and a small quantity of jeweller's *rouge*

(i) The composition of the earth, as found in use at the works, but rendered anhydrous, is as follows:—

Quartz	...	...	38·4
Combined Silica		...	24·2
Alumina	...	...	26·3
Ferric oxide	...	...	10·5
Magnesia	...	...	0·3
			—
			99·7

(ferric oxide), was treated exactly as above—a crystalline sublimate of calomel was at once obtained, with only a faint trace of corrosive sublimate. There was very little free mercury left.

III. The experiment under ii was repeated, only alumina being substituted for ferric oxide—almost chemically pure calomel was obtained, the yield being rather less.

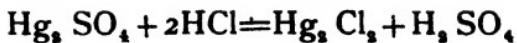
IV. Mercury, was vapourised in a current of air mixed with hydrochloric acid gas—calomel was formed, but the yield was proportionately very much less than in i; by far the largest amount of mercury volatilised as such and condensed in the cooler parts of the tube as globules.¹

The formation of calomel as in exp. IV. is, in itself, an interesting reaction and it is rather surprising that Roscoe and Schorlemmer's latest edition of the standard work on Chemistry fails to take

(1) The author avails himself of this opportunity to express his indebtedness to Mr. Chandrabhúshana Bháduri, B.A., Demonstrator, Chemical Dept., Presidency College, with whom he has, of late, had frequent discussions on the chemistry of the Japanese Process. It was Mr. Bháduri who hit on the true explanation as given above. The experiments i, ii, iii and iv were all performed by him. As Mr. Bháduri has expressed a desire to work out the subject in all its bearings, we can confidently look forward to some very interesting results.

note of it. Our contention, however, is that the traces of air that would diffuse through the porous lid would give rise to a quantity of calomel which may almost be regarded as negligible. For the true explanation, as we have already pointed out, we should look to the presence of *ferric oxide*. Our view receives additional support from the fact that the residue in exp. ii. was found to contain *ferrous chloride*.

The Chinese method as also that of the Latin Geber recommends the addition of saltpetre as thereby more of corrosive sublimate would be formed than calomel, and this purpose is equally served in the process of Bhāvaprakāsa which uses, over and above brick-dust, *gairika* (red ferruginous earth, see p. 139), thus further increasing the chlorinating capacity. Professor Divers is of opinion that the sulphuric acid set free by alum acts upon sodium chloride giving rise to hydrochloric acid (*loc. cit.*) and does nothing more; our view is that the sulphuric acid simultaneously acts in a two-fold capacity; first, it liberates hydrochloric acid; secondly, it acts upon mercury forming mercurous or mercuric sulphate as the case may be and then double decomposition takes place between the two, thus :



The sulphuric acid in turn acts upon a fresh quantity of sodium chloride and mercury and so on. By far the larger portion of the chlorides of mercury would seem, however, to be formed through the agency of the ferric oxide.

The processes of "Rasendrachintāmani" and "Bhāvaprakāsa" were also put to an experimental test, the globules of mercury were broken up by being rubbed continuously with a mixture of brick-dust, alum and common salt, and the mass was transferred to a stout bottle, which was wrapped in several folds of cloth, smeared with clay¹. The bottle was embedded in sand and heated for 3 hours ²—*vide* illustration. The sublimate that was obtained was a mixture of calomel and mercuric chloride; in one experiment brick-dust

(1) The experiments were conducted under the author's personal supervision by Kavirāj Prakritiprasanna Kaviratna, who is well skilled in the Hindu methods of *killing* metals.

(2) The heating for 3 or 4 days together as recommended in the Hindu method need not be taken seriously, indeed it must be regarded as an *extravagansa* of the old alchemists. Professor Divers in applying his theory of *aerial oxidation* to the Chinese process has been led to suppose that it "takes 4 or 5 hours' firing, since this may give time enough for the needed oxygen to diffuse through the cup and luting."

was omitted and the product was pure calomel¹. There was necessarily some loss of mercury by volatilisation in these cases and the yield was short of the theoretical quantity. It will be seen that common salt, with alum or green vitriol, is quite competent to convert mercury into calomel; but the addition of brick-dust increases the chlorinating capacity, giving rise to a certain proportion of corrosive sublimate, which can probably be avoided by gentle heating as in the Japanese method.

APPENDIX I

Analysis of some Preparations used in the Hindu Medicine

ÆTHIOPS MINERAL

(Kajjali or rasaparpati p. 61)

As might be expected from its mode of preparation, the substance always contains a large excess of free sulphur.

(1) Dutt writes:—"The white form called *rasakarpura* is now prepared, not according to the processes described in Sanskrit works, but by subliming the black sulphide of mercury with common or rock salt. In this form it is largely manufactured and sold in all the bazars."

0·645 gram subst.; digested with carbon bisulphide, yielded 0·2845g. sulphur: whence free sulphur amounts to nearly 44 per cent.

SULPHIDE OF COPPER

(Parpati tāmram p. 58)

0·704 g. subst., heated in a current of hydrogen with powdered sulphur (Rose's method); till the weight was constant, gave 0·697 g. It is thus evident that this preparation is nearly pure cuprous sulphide (Cu_2S).

CALOMEL

(Rasakarpūra, p. 250)

Five samples, procured from the market and prepared according to the indigenous method, when exhausted with water gave in the filtrate only faint brown coloration with sulphuretted hydrogen. It is thus evident that these were all free from corrosive sublimate.

Dutt, we are afraid, derived much of his information on chemical subjects from hearsay. By "subliming the black sulphide of mercury with common salt," we got, as we expected, merely cinnabar. The sodium chloride was simply left behind. It is to be regretted that the new edition of Dutt's valuable work, which claims to be "revised," reproduces all the glaring errors of the first.

RUST OF IRON

(*Mandūra*, p. 111)

Hindu physicians generally procure the scales from the black-smith's forge, which peel off the red-hot bars of iron, when they are struck on the anvil with an iron hammer. These are subjected to further roasting, sometimes as many as 500 times and powdered very fine.

Sample I

The powder was reddish brown in colour; and slightly magnetic; 0.6638 g was boiled a few hours with hydrochloric acid in a current of carbonic acid gas. On adding a drop of potassium ferricyanide solution to a drop of the iron solution, a faint blue colour was noticed. Weight of insoluble residue, which was simply siliceous matter, was equal to 0.107g; the oxide of iron was therefore equal to $0.6638g - 0.107g = 0.5568g$. The solution, distinctly yellow in colour, was treated with ammonia and the precipitate, ignited in the usual way, weighed 0.560 g. The sample was thus practically ferric oxide (Fe_2O_3).

Sample II.

It was magnetic and of dark iron colour; 0.259g, digested as above with hydrochloric acid, gave as residue (sand &c.) 0.131g, Wt. of the real oxide=128 g. The solution was treated with ammonia and the precipitate, ignited as usual, weighed 0.130 g. The latter was once more dissolved in HCl and tested with K₃Fe Cy₆; but no indication of a *ferrous* salt was obtained. It is thus evident that both the samples contained only a trace of ferrous oxide.

As a check upon the above analyses, black scales were procured from a smith's and examined. These were carefully sifted by means of an electromagnet and freed from dust and other foreign impurities. 0.622 g scales was heated in a platinum crucible over a blow-pipe flame and cooled at intervals, till the weight was constant at 0.649g.

Now Fe O. Fe₂O₃ thus becomes Fe O_{3/2}. Fe₂O₃ or 232g " 240g

$$\text{Now } 0.622 \times \frac{240}{232} \text{ g} = 0.643 \text{ g}$$

The difference between the theoretical amount and that actually found is thus only 6 milligrams. This is no doubt due to the scales enclosing minute traces of *metallic* iron.

In the Hindu method of *killing* and purifying metals, the juices expressed from various plants are frequently used (cf. pp. 61, 132). The ashes of plants rich in potash are also utilised as a source of alkali. (Cf. pp. 35-36). We give below one or two typical analyses.

(i) *Achyranthes aspera* (अपामान) :

"The ashes are used by the Hindus in preparing alkaline preparations. The diuretic properties of the plant are well known to the natives of India, and European physicians agree as to its value in dropsical affections.

* * * *

Chemical composition.—The whole plant collected in August was used. A proximate analysis failed to indicate the presence of any principle of special interest. No alkaloidal body was detected, and the alcoholic extract contained no principle reacting with ferric salts.

"For the ash determination, the roots, stems and leaves were separately examined with the following results :—

	LEAVES.	STEMS.	ROOTS.
P ₂ O ₅	3·0257	2·6939	1·8504
SiO ₂ as Sand.....	39·7192	12·9716	21·4219
SO ₃	1·3200	2·6534	3·9523
CaO.....	13·8893	13·1233	12·9335
MgO.....	3·4778	3·5149	5·4419
K ₂ O.....	17·8454	32·0008	28·5830
Na ₂ O.....	.....	.....	·9860
Fe ₂ O ₃	2·7931	3·0352	5·6297
Manganese.....	Traces, not estimated.	Not estimated	Not estimated.
KCl.....	5·7416	9·5221	.....
NaCl.....	1·1770	1·5261	3·2951
Al ₂ O ₃	2·0651	Not estimated.	Not estimated.
CO ₂	8·8687	13·6294	11·0057
Carbon.....	·3297	·5525	Not estimated
	100·2526	95·2232	95·1085

"The leaves, stems, and roots dried at 100°C., afforded respectively the following percentages of ash,—Leaves, 24·334; stems, 8·672; roots, 8·863. The large amount of sand present in the ash is due to the fact of the plants having been collected during the rains, and when received they were coated with finely divided siliceous matter.

"The total potash calculated as K₂O was equivalent in the leaves to 21·4986 per cent., in the

stems to 38.0122 per cent., and in the roots to 28.5830 per cent. It is possible that the plant might be of value as a cheap green manure on account of potash content. (Warden, *Chem. News*, Vol. ii., 1891)."

(ii) Juice of *Trianthema monogyna* (त्रियुग्नीया) :

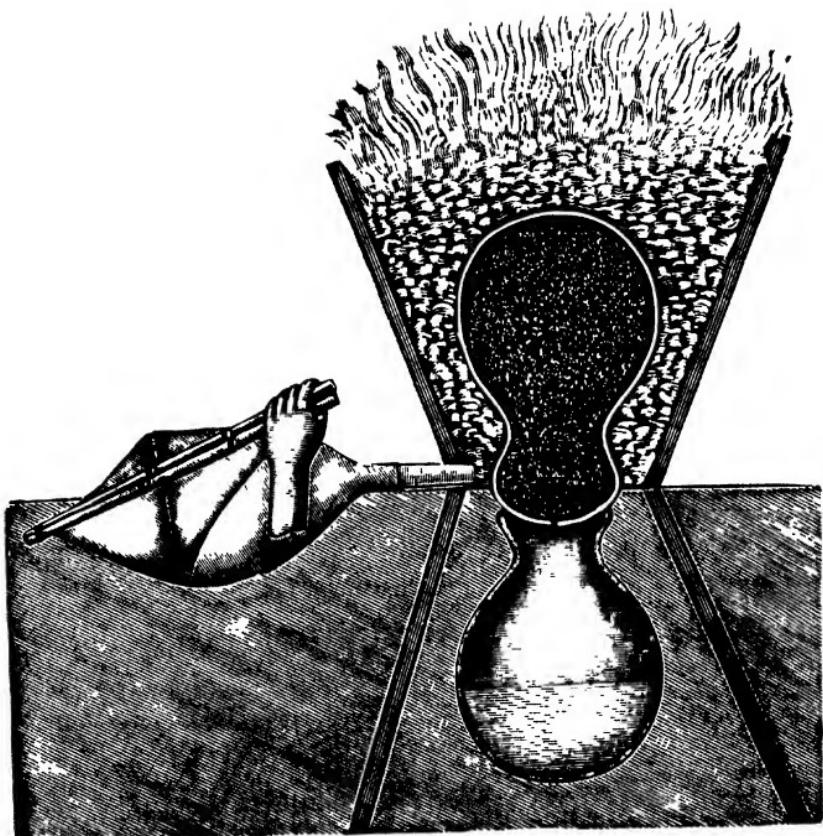
Although *Punarnava* is *Boerhaavia diffusa*, the plant universally used by our *Kavirajes* as त्रियुग्नीया, is different. A sample was submitted to the authorities of the Royal Botanical Gardens, Sibpur, for examination, and it was identified as *Trianthema monogyna* (nat. ord. Ficoidæ). On chemical analysis of the juice of the succulent stems, we found it to consist of a large proportion of potassium and sodium chlorides; a nitrate was also detected. The cooling and diuretic properties of the plant are thus easily explained.

APPENDIX II

Sir P. C. Ray
at young age



Sir P. C. Ray at old age



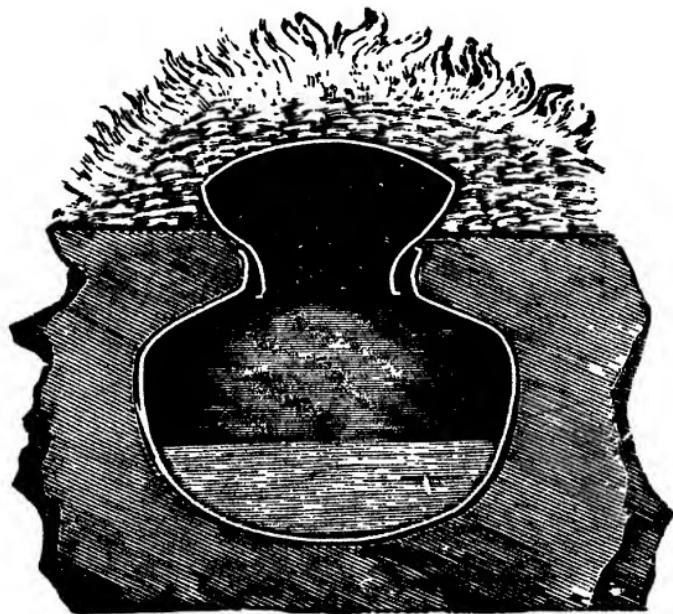
Koshthí apparatus,
for the extraction of zinc from calamine. (See p. 89)



Dolā vantram. (See p. 121)



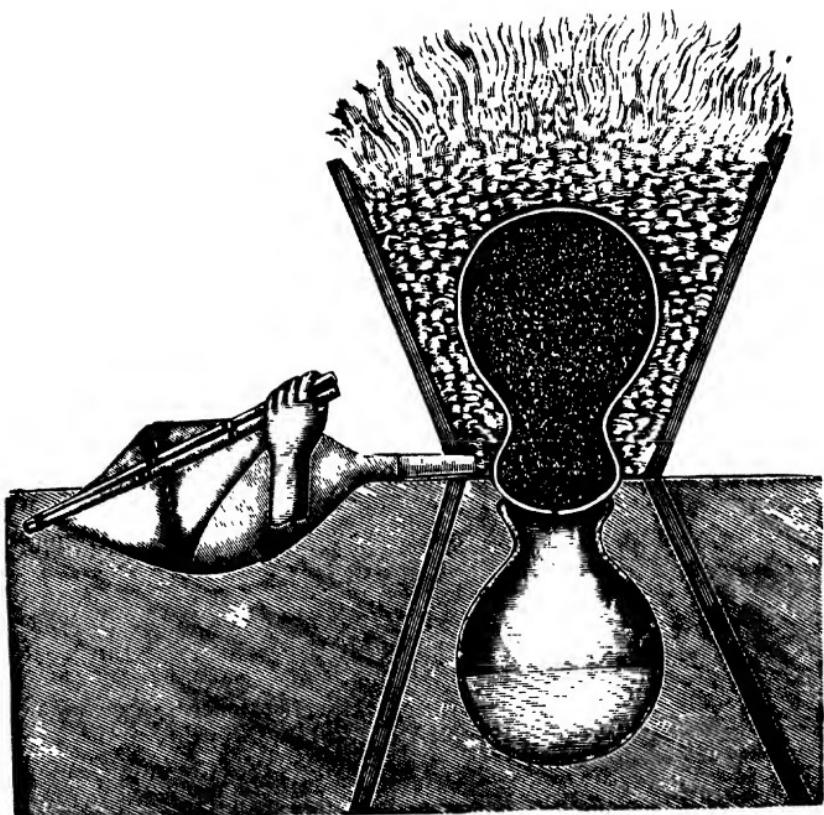
Svedani yantram. (See p. 122)



Adhaspatana yantram. (See p. 122).



Valuka yantram (See p. 123)



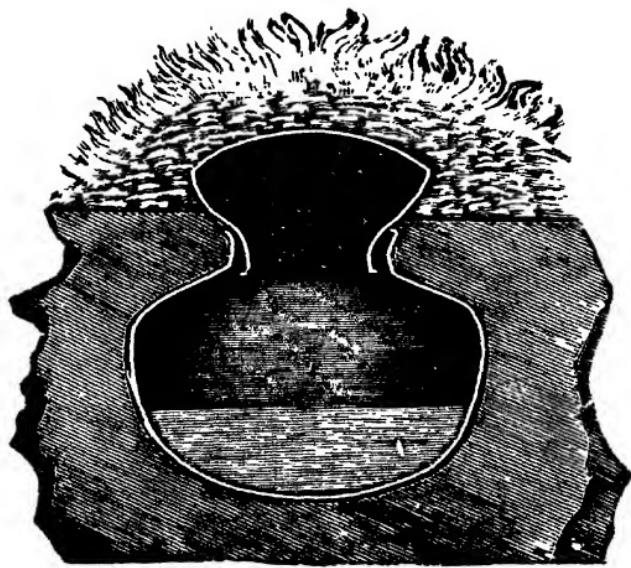
Koshthí apparatus,
for the extraction of zinc from calamine (See p. 89)



Dolā yantram. (See p. 121)



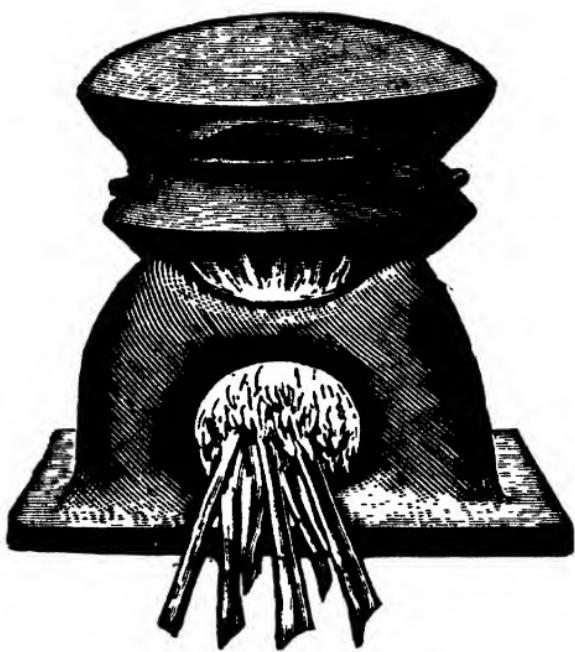
Svedanī yantram. (See p. 122)



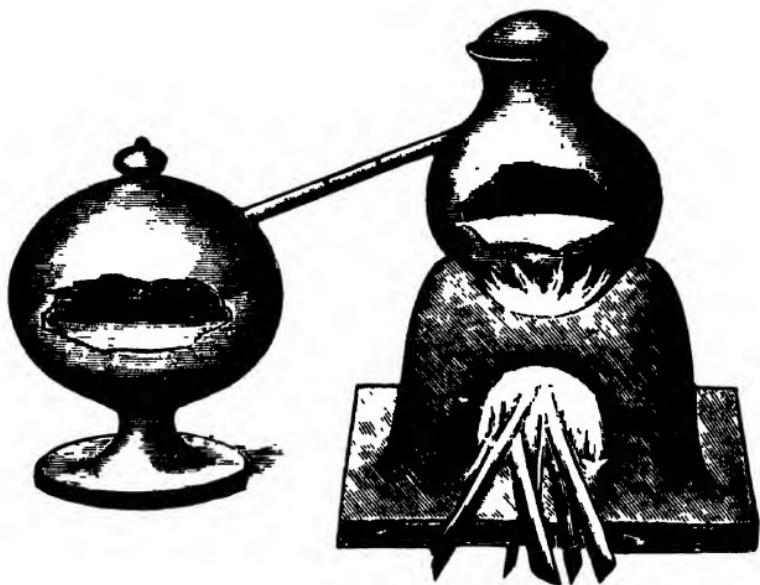
Adhaspatana yantram. (See p. 122).



Valuka vātrām (See p. 123)



Pātatrā yantram. (See p. 122).



Dhekî yantram. (See p. 123)

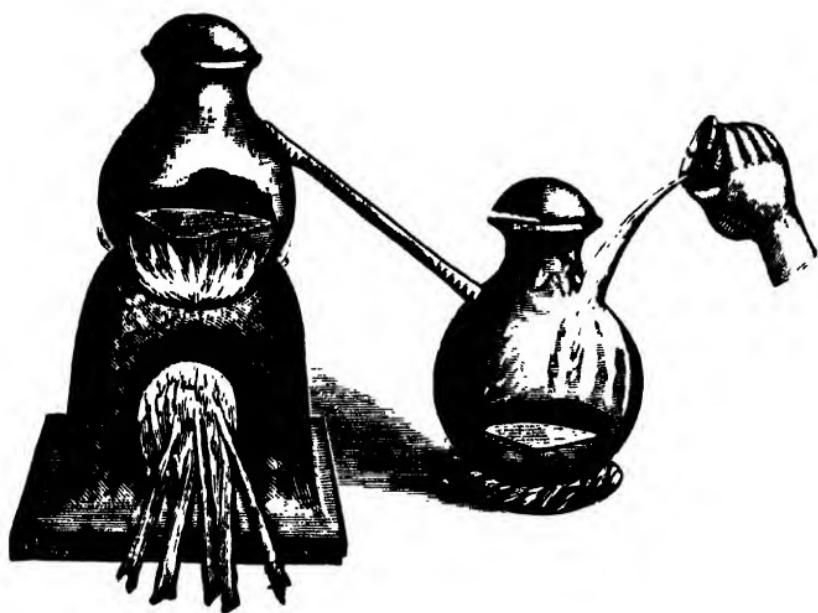


Alum and Sulphate of Copper Works Khetri.

From Ball's Economic Geology of India (See p 148)



Tiryakpitana yantram. (See. p. 124).



Vidyādhara yantram. (See p. 124).



Dhūpa yantram. (See p. 125)



Copper Reducing Furnace at Khetri.

From Ball's Economic Geology of India. (See p. 140-41)

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SANSKRIT TEXTS

Sanskrit Texts

Extracts from Vrinda

Abbreviations used : M. Ms. = Madras Manuscript.

K. Ms. = Kásmír Manuscript.

R. R. S. = Rasaratnasamuchchaya.

Rr. by Nág. = Rasaratnákara by
Nágárjuna.

हृष्टिखितसिद्धयोगादुदृतानि वचनानि—

रसेन्द्रेण समायुक्तो रसो धनूरपञ्चजः ।
ताम्बूलपञ्चजो वाय लेपनं यौकनाशनम् ॥ VI, 13.
विफलाव्योषसिम्बूत्ययष्टीतुत्यरसाज्जनम् ।
प्रपौण्डरीकं जन्मुज्जं लोध्रं ताम्बं चतुर्दश ॥
द्रव्यास्तेतानि संचूर्ष्ण वर्त्तिः कार्या नभोऽस्मुगा ।
नागार्जुनेन लिखिता स्तम्भे पाटलिपुत्रके ॥

LX, 148-149.

सर्वेषां सोहजातानां कान्तं भवति कान्तिदम् ।

* * पाचयेन्नोहमादौ वस्तदिने ततः ॥

धात्रीपिण्डारकोहूतस्वरसेनाकरश्मिषु ।
 खापयेत् * * * * ॥
 काकमाचौरसे पश्चात् * * ।
 पुनर्भूम्यान्ते सर्वच खलितव्यं प्रयत्नतः ॥
 पश्चाच्छूर्णं विधातव्यमप्रमत्तेन धीमता ।
 इति सूर्यमुखेनैव मारणं परिकौत्तिंतम् ॥
 * * * * लोहमारणम् ।
 रसगन्धकताम्बाणां चूर्णं छत्वा समाच्चिकम् ।
 पुटपाकविधौ पक्का मधुनालोद्य संलिहेत् ॥
 सर्वरोगहरच्छेतत्पर्पटाख्यं रसायनम् ॥
 पर्पटीताख्यं, रसायनाधिकारः ।
 कर्षदयं गन्धकस्य तदर्द्धं पारदस्य च ।
 विढालपदमावन्तु लिङ्गात्ममधुसर्पिषा ॥
 रसामृतचूर्णम्, अम्लपित्ताधिकारः ।

(1) The ed. of ३८ published by the Ananda-Srama Press, Poona, does not contain the last three slokas, which, however, occur in the K. Ms. of the same.

Extracts from Rasarnava

रसार्णवादुद्धताः स्तोकाः ।

श्रीभैरव उवाच—

रसोपरसलोहानि वसनं काञ्जिकं विडम् ।
धमनी लोहयन्त्राणि खल्पपाषाणमर्हकम् ॥
कोषिका वक्रनालच्च गोमयं सारमिथ्यम् ।¹
मृत्यानि च यन्त्राणि मुसलोलूखलानि च ॥
संड़सीयन्त्रसंदंशं मृत्यात्रायःकरोटकम् ।²
प्रतिमानानि च तुला क्षेदनानि कषोत्पलम् ॥
वंशनाली लोहनाली मूषामार्गस्तथौषधी ।
स्त्रेहान्त्वलवणक्षारविषारख्युपविषाणि च ॥

(1) Cf. कोषिका वक्रनालच्च गोमयं सारमिथ्यम् ।

Rr. by Nag. Ch. IV.

(2) M. Ms. reads अष्टपौपहसन्दंशां मृत्याच येकमोरकम् ।

(3) M. Ms. has कषोत्पलम् ।

एवं संज्ञा सच्चारं कर्मयोगं समाचरेत् ॥
 द्रवद्रव्येण भाण्डस्य पूरितार्द्दरस्य च¹ ।
 मुखे तिर्थक्षते भाण्डे रसं सूचेण लभ्वितम् ।
 तं स्वेदयेत्तत्र गतं दीलायन्वमिति सृतम् ॥
 लोहमूषाहयङ्कला इदशाङ्कुलमानतः ।
 ईषच्छिद्रां छिद्रमितामेकां गन्धकसंयुताम् ॥
 मूषायां रसयुक्तायामत्यस्यां तां प्रवेशयेत् ।
 तोयं स्यात्सूतकस्थाध जड्हाधो वङ्गिदीपनम् ॥
 रसोनकरसं भद्रे यद्वतो वस्त्रगालितम् ।
 दापयेत्तुरं यद्वादाप्नाव्य रसगन्धकौ ॥
 स्यालिकायां निधायोर्द्धं स्यालीमन्यां दृढां कुरु ।
 सम्बिं विलेपयेदयनामृदा वस्त्रेण चैव हि³ ॥

(1) K. Ms. reads भाण्डस्य पूरितार्द्दरसेन च । The reading adopted in the text is that of the M. Ms., which quite agrees with R. R. S. (see p. 73, Poona ed.)

(2) M. Ms. reads ईषच्छिद्रामेकाम् ।

(3) Rr. by Nag. reads अथे तु रबसंस्तिः ।

स्वात्मन्ते कपोताख्यं पुटं कर्षाग्निना सदा ।
 यन्वस्याधः करीषाग्निं दद्यात्तीव्राग्निमेव च ॥
 एवन्तु त्रिदिनं कुर्यात्तमतोये विमर्हयेत् ॥
 न तच्च त्रौयते सूतो न च गच्छति कुत्रचित् ॥
 अर्द्धं वक्त्रिरध्यापो मध्ये तु रससङ्घः ।
 मूषायन्वमिदं देवि जारयेद् गन्धकादिकम्² ॥
 गर्भयन्तं प्रवक्ष्यामि पिण्डिकाभस्मकारकम् ।
 चतुरङ्गलदीर्घां³ च मूषिकां सून्धयों दृढाम् ॥

(1) M. Ms. has सारथत

(2) गगनादिकम् in R. S. S. (p. 74, Poona ed.)

Couplets खीड़मूषादयं गच्छति कुत्रचित् have been borrowed by R. R. S. in the Book on apparatus.

(3) Rr. by Nag. reads—

सत्रहुलदेवेण विकारणं च त्रहुलम् ।
 मूषान्तु सून्धयों कर्यात् सहडां वर्षलां बुधः ॥
 विश्वभागानि खीषस्य भागस्मकम् गुणगुणोः ।
 सुस्पर्शं पिण्डित्वा तु सोयं दत्त्वा पुनः पुनः ॥
 मूषालं पं हठं बडा लोणार्थं चर्षिकां बुधः ।
 कर्यात्सुषाग्निं भूमी च सदुस्वेदेन खेदयेत् ॥

अङ्गुलमध्यविस्तारं वर्तुलं कारयेन्मुखम् ।
 लोहस्य^१ विंशतिर्भागा एकभागसु गुगुलोः ॥
 सुश्वस्त्राणं पेषयित्वा त तोयं दद्यात्पुनः पुनः ।
 मूषालेपं ततः कुर्यात्तिलपिष्टस्त्रं निच्छिपेत्^२ ॥
 कुर्यात्तुषामिनं भूमौ तः सूदूस्तेदन्तु कारयेत् ।
 अहोरात्रं त्रिरात्रं वा रसेन्द्रो भस्मातां ब्रजेत् ॥
 जारणे सारणे चैव रसराजस्य रच्छने ।
 यन्त्रमेव परं कर्म यन्त्रविद्या महाबला ॥^३
 औषधिरहितश्चायं हठाद्यन्तेण वध्यते ।
 तस्माद्यन्तबलच्छैकं न विलंघ्यं विजानता ॥ ३-२४.
 खर्पं सिकताकारं कृत्वा तस्योपरि व्यसेत् ॥
 अपरं खर्पं तत्र श्वर्नैर्मृदग्निना पचेत् ॥
 पञ्चश्चारेस्तथा भूत्वैर्लवण्यस्त्रं विष्ट्रुतः ।
 हुंसपाकः स विज्ञातोऽ यन्त्रतत्त्वार्थकोविदैः ॥

(1) K. Ms. reads लोहस्य ।

(2) K. Ms. has तिलप्रष्टं सुनिच्छिपेत् ।

(3) M. Ms. reads तुषकर्षपिना भूमौ ।

(4) M. Ms. has यन्त्रैषवं परं कर्म यन्त्रविद्या महारसम् ।

(5) M. Ms. reads हुंसपादसु विज्ञातः ।

HINDU CHEMISTRY

क्षणा रक्ता च पौता च शुक्रवर्णा¹ च मृत्तिका ॥
 आद्या शेषा कनिष्ठा च मध्यमा मध्यमा मता ॥
 दग्धधान्यतुषोपेता मृत्तिका कोष्ठकारिका² ।
 वक्रनालक्ते वापि शस्यते सुरसुन्दरि ॥
 गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ।
 अजाखानां मलं दग्धं दग्धा मृत्क्षणतां गता ॥
 वासकस्य च पत्राणि वल्मीकस्य मृदा सह ।
 पेषयेदमितोयेन अनेन वज्रतां गतम् ॥
 मर्दयेत्तेन बभीयाहकनालच्च कोष्ठकम् ॥
 गौरा दग्धा तुषा दग्धा दग्धा वल्मीकमृत्तिका ॥
 चिरमङ्गारकः किञ्च वज्रेणापि न भिद्यते ।
 दग्धाङ्गारस्य षड्भागा भागैका क्षणमृत्तिका ॥
 चिरमङ्गारकः किञ्च वज्रमूषा प्रकीर्तिता ॥
 तुषदग्धसमा दग्धमृत्तिका चतुरंशिका ।
 वर्णपाषाणसंयुक्ता³ वज्रमूषा प्रकीर्तिता ॥

(1) M. Ms. has शुक्रक्षणा ।

(2) M. Ms. reads कोष्ठकादधो ।

(3) M. Ms. has कुप्यपाषाणसंयुक्ता ।

प्रकाशा चान्वमूषा च प्रकृतिर्दिविधा शृता ।
 प्रकाशमूषा देवेशि शरावाकारसंयुता ॥
 द्रव्यनिर्वाहणे सा च वैदिकैः सुप्रशस्तते ॥
 अन्वमूषा तु कर्तव्या गोस्तनाकारसन्निभा ।
 पिधानकसमायुक्ता किञ्चिदुत्तानमस्तका ॥
 पत्रलेपे तथा भागे² इन्द्रमेलापके तथा ।
 सैवाच्छिद्रान्विता मध्ये गम्भीरा सारणोचिता ॥
 मोक्षकारस्थ³ भागौ हौ इष्टकांशसमन्वितौ ।
 शृङ्गागास्तारशुद्धर्थमुक्तमा वरवर्णिनि ॥ 29-46.
 आवर्त्तमाने कनके पौता तारे सिता शुभा ॥
 शुखे⁴ नौलनिभा तौद्देषे क्षणवर्णा सुरेश्वरि ॥
 वङ्गे ज्वाला कपोता च नार्गे मलिनधूमता ॥
 शैले तु धूसरा देवि आयसे कपिलप्रभा ॥

- (1) M. Ms. reads सा चावैदिकैन् प्रशस्तते ।
- (2) M. Ms. has रक्ते ।
- (3) M. Ms. reads मोक्षकारस्थ ।
- (4) K. Ms. has युक्ते, which seems to be incorrect.

अयस्कान्ते धूमवर्णा सस्यके लोहिता भवेत् ॥
वज्जे नानाविधा ज्वाला सस्यके¹ पाण्डुरप्रभा ॥

न विस्फुलिङ्गा न च बुद्धाश
यदा न रेखापटलं न शब्दः ।
मूषागतं रत्नसमं स्थिरच्छ
तदा विशुद्धं प्रवदन्ति लोहम् ॥

षोडशाङ्गुलविस्तीर्णं हस्तमात्रायतं शुभम् ।
धातुसत्त्वनिपातार्थं कोष्ठकं वरवर्णिनि ॥ 49-57.
इति श्रीपार्वतीपरमेष्वरसंवादे रसार्णवे रस-
संहितायां यन्मूषाग्निवर्णनो नाम चतुर्थः पटलः ।

त्रिक्षाराष्ट्रगुणक्षारो यवक्षारश्च सर्जिका ।
तिलापामार्गकदलौपलाशशियुमोचकाः ।
मूलार्दकचिच्छाश्वस्या वृक्षक्षाराः प्रकौर्त्तिः ॥

V. 35-36.

माद्रिकं विमलं शैलं² चपलो रसकस्तथा ।

(1) M. Ms. reads खस्त्वे

(2) K. Ms. हृष्ण शिळा ।

सत्यको दरदस्वैव स्रोतोऽच्छनमथाष्टकम्¹ ।

अष्टौ महारसाः * * * || VII. 2-3.

चौद्रगन्धवंतैलाभ्यां गोमूचेण घृतेन च ।

कदलीकन्दसारेण भावितं माच्चिकं सुहुः ।

मूषायां मुच्छति धातं सत्त्वं शुखनिभं मृदु ॥ 12-13.

विमलं शिश्रुतोदयेन काञ्चीकासीसटहर्णः ।

बज्जकन्दसमायुक्तं भावितं कदलीरसैः ॥

मोच्चिकाचारसंयुक्तं धापितं मूकमूषया ।

सत्त्वं चन्द्रार्कसङ्खाशं प्रयच्छति न संशयः ॥² 20-21.

गौरः श्वेतोऽरुणः क्षणशपलसु प्रशस्यते ।

हेमाभस्वैव ताराभो विशेषाद्रसवन्धकः ॥

(1) K. Ms. reads श्रीताञ्छनकथाष्टकम्, which is incorrect.

(2) विमलं शिश्रुतोदयेन काञ्चीकासीसटहर्णैः ।

बज्जकन्दसमायुक्तं भावितं कदलीरसैः ॥

मोच्चिकाचारसंयुक्तं धापितं मूकमूषगम् ।

सत्त्वं चन्द्रकिसङ्खाशं प्रताति नाच संशयः ॥

शेषी मध्यौ च लाक्षावच्छीवद्रावौ तु निष्कलौ ।

वङ्गवद्वते वङ्गौ च पलस्तेन कौर्त्तिः ॥ 26-27.

मृत्तिकागुणपाषाणभेदेतो¹ रसकस्तिधा ॥ VII. 31.

किमत्र चित्रं रसको रसेन,

* * * भावितः ।

क्रमेण भूत्वा तुरगेण रच्छितः

करोति शुख्यं² चिपुटेन काञ्चनम् ॥³ VII. 34.

जर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।

मूकमूषागतो आतषङ्गेन समन्वितः ॥

सत्त्वं कुटिलसङ्घाशं सुच्छत्यन्न न संशयः ॥⁴

VII. 37-38.

(1) M. Ms. has भेदकः ।

(2) M. Ms. reads गम्भम् ।

(3) This sloka is exactly the same as it is in
Rr. by Nág. I. 3.

(4)- जर्णालाक्षातथापथ्या-भूलताधूमसंयुतः ।

क वागती आतषङ्गेन समन्वितः ।

सत्त्वं कुटिलसङ्घाशं पतति नान् संशयः ।

Rr. by Nág. II. 31-32.

सत्यकं * * * *

शशशोणितमध्ये वा दिनमेकं निधापयेत् ।

तस्य चूर्णं महेशानि पादसौभाग्यसंयुतम्¹ ॥

करञ्जतैलमध्यस्थं दिनमेकं निधापयेत् ।

मध्यस्थमन्धमूषायां धापयेकोकिलावयम् ॥

इन्द्रगोपकसङ्खारं सत्त्वं पतति शोभनम् ॥ VII. 41-44.

गोपित्तेन शतं वारान् सौराष्ट्रीं भावयेत्ततः ॥

धर्मित्वा पातयेत्सत्त्वं क्रामणचातिगुद्धकम् ॥

VII. 72-73.

* * * शृणु लोहान्वतः परम् ।

सुवर्णं रजतं ताम्बं तौल्यावङ्गभुजङ्गमाः ।

लोहकं पद्मिधं तच यथापूर्वं तदच्चयम् ॥ VII. 89-90.

रसजं² क्षेत्रजसैव. लोहसङ्खरजं तथा ।

त्रिविधं जायते हेम चतुर्थं नोपलभ्यते ॥ VII. 92.

लोहानां मारणं वस्त्रे समाहितमनाः शृणु ।

* * * *

(1) M. Ms. reads पादसान्नायसंयुतम् ।

(2) M. Ms. has रजस्तं, which is doubtful.

नास्ति तस्मोहमातङ्गो यत्र गन्धकेशरी ।
निहन्याहन्यमात्रेण यहा मात्रिकेशरी ॥

VII. 138-142

इति श्रीपार्वतीपरमेष्ठरसवाटे रसार्णवे रस-
संहितायां भवते। रसोपरसरबलोहलया॥ संस्का॥ निर्णयो
नाम सप्तमः पटलः ।

श्रीभैरव उवाच --

कासीसं सैन्यवं मात्रौ सौवौरं व्योषगन्यकम् ।
सौवर्चलं व्योषका च मालतौरससभ्वः ॥¹
शिघ्रमूलरसैः सिक्तो व्रिडोऽयं सर्वजारणः ॥²

IX. 2-3.

* * * *

(1) M. Ms. h.25 मर्जिका and मालतीन रमननग् .

(2) Cf. Risikalpa II, 51-66. Mr. ज्ञानवगच्छी, सर्जिका and रमनयुतैः seem to be correct.

गन्धतालकसिन्धूयचूलिकाशङ्कणं तथा ।
ज्वारैर्मूचैश्च विपचेदयं ज्वालामुखो विदुः¹ ॥

* * * * *

एवं संग्रह्य सम्भारं रसकम्यं समाचरेत् ।
तममाचक्ष देवेशि किमन्यच्छ्रोतुमिच्छसि ॥

IX. 9-20.

इति श्रीपार्वतौपरमेश्वरसंवादे रससंहितायां
विदुकथनो नाम नवमः पटलः ।

काकमाचौ जया ब्राह्मौ मार्जारौ रक्तचित्रकः ।
मण्डूका मुहूर्पर्णी च शृङ्खवेरं सशाङ्करम् ॥
देवदालौ शङ्खपुष्पौ काकजड्णा शतावरी ।
कुमारौ भङ्गराजश्च निर्गुण्डौ श्रीमस्त्वरः ।
शूलिनी सूर्यपर्णी च गोजिह्वा शौरकञ्चुकः ॥

X. 52-54.

(1) K. Ms. reads अयं ज्वालामुखो विदुः, which is grammatically incorrect.

तद्रसैः सर्वदा^१ पात्यः सप्तधा निर्वलो भवेत् ।
 यामेन^२ पिण्डिकां कुत्वा पातयेदूर्घपातने ।
 वज्ञनागौ परित्यज्य शुद्धो भवति सूतकः ॥

X. 55-56.

कासौसतुवरौसिभुट्टणक्षारसंयुतः ।
 पूर्वभेषजयोगीन सूतकस्वरति द्वयात् ॥ XI. 24.
 सौवर्जलच्च कासौसं सामुद्रं सैध्यवं तथा ।
 आसुरी टट्टणच्चैव नवसारस्त्यैव च ॥
 कर्पूरच्चैव माक्षीकं समभागानि कारयेत् ॥
 मुख्यकंदुरधैदेवेशि मूषालेपन्तु कारयेत् ॥
 विड्धूर्णं ततो दत्त्वा कनकं जारयेत्प्रिये ॥

XI. 83-86.

नानावरणं भवेत्सूतं विहाय घनचापलम् ।
 लक्षणं दृश्यते यस्य मूर्च्छितं तं वदन्ति हि ॥
 आर्द्रत्वं चपलत्वं^३ च तेजो गौरवचापलम् ।

(1) M. Ms. has नदितम् ।

(2) M. Ms. reads तावेष ।

(3) M. Ms. reads घनत्वम्, which is preferable.

यस्यैतानि न हृश्यन्ते विद्यात्मं मृतसूतकम् ॥¹

XII. 197-198.

तौह्लां नागं तथा शुखं रसकेन तु रच्छयेत् ।

समस्तं जायते हेम कुञ्चारण्डकुसमप्रभम् ॥ XII. 50.

पञ्चभूतात्मकः सूतस्तिष्ठत्येव सदाशिवः ॥ XII. 78.

भस्मसूतं पलैकञ्च पलमेकञ्च² गन्धकम् ।

पुटेन जायते भस्म सिन्दूरारुणसन्निभम् ॥ XIV. 81.

मयूरश्चौवतुत्यच्च कुञ्चुमं रसकं तथा ।

बालवस्तपुरीषच्च विषं हालाहलं तथा ॥

रक्तचित्रकचूर्णन्तु समभागानि कारयेत् ।

मर्दयेन्नध्यमाल्लेन छायाशूक्षच्च कारयेत् ॥

(1) Cf. आर्द्रत्वच्च घनत्वच्च चापल्यं गुरुतेजसः ।

यस्यैतानि न हृश्यन्ते सं विद्यान्मृतसूतकम् ॥

जानावणे भवेत्सूतं विहाय घनचापलम् ।

लच्छणं हृश्यते यस्य मूर्च्छितं तं बदलि हि ॥

Rr. by Nag. IV.

(2) M. Ms. has * * * पलैकं पञ्चगच्च च ।

ताम्बपात्रेच तं छात्वा मर्दयेन्नोहसुद्धिना ।

सहस्रिना ततः पाञ्च यावद्वारिन निष्कर्तम् ॥

मधुना सह संयोज्य नागपत्राणि लेपयेत् ।
 मूकमूषागतं धातं नागं रक्षयति द्वणात् ॥
 अशोकपत्ररसेन सप्तवारं निषेचयेत् ।
 अष्टाविंशतिक्षत्वो वै तैले भूनागसभवे ॥
 तनागं जायते दिव्यं देवाभरणभूषणम् ॥

XVII. 70-74.

Extracts from
Rasaratnasamuchchaya.

B. = Benares Manuscript.

K. = Kashmir Manuscript.

अथ प्रथमोऽध्यायः ।

रसोत्पत्तिः ।

यस्यानन्दभवेन मङ्गलकलासभावितेन स्फुर-
द्वान्ना सिद्धरसामृतेन करणावीक्षासुधासिद्धुना ।
भक्तानां प्रभवप्रसंदृतिजरारागादिरोगाः चणा-
च्छालिं यान्ति जगत्प्रधानभिषजे तस्मै परस्मै नमः ॥ 1.

आगम^१शन्द्रसेनश्च लहूश्च विश्वारदः ।

कपाली मत्तमाण्डव्यौ भास्करः शूरसेनकः ॥

(1) आगमः, a variant in the Poona ed., which also agrees with B. and K.

रबकोषश्च¹ शम्भुश्च सात्त्विको नरवाहनः ।
 इन्द्रदो गोमुखस्यैव कम्बलिवर्याङ्गिरेव च ॥
 नागार्जुनः सुरानन्दो नागदोधिर्यशीधनः ।
 खण्डः कापालिको ब्रह्मा गोविन्दो लम्पको हरिः ॥
 सपविंशतिसंख्याका रससिद्धिप्रदायकाः ।
 रसाङ्गुशो भैरवश्च नन्दी सच्छन्दभैरवः ॥
 मन्यानभैरवश्चैव काकचण्डौखरस्थथा ।
 वासुदेव ऋषशृङ्गः² क्रियातन्वसमुच्चयौ ॥
 रसेन्द्रतिलको योगी भालुकी भैरिलाहयः ।
 महादेवो नरेन्द्रश्च वासुदेवो हरौखरः³ ॥ 2-7.
 एतेषां क्रियतेऽन्येषां तन्माण्यालोक्य सङ्घः ।
 रसानामथ सिद्धानां चिकित्सार्थोपयोगिनाम् ॥

(1) रबधावश, another reading in the Poona ed., which also agrees with B. and K.

(2) ऋषशृङ्गः, a different reading in the Poona ed., which also agrees with B. and K.

(3) K. reads रबाकरइरीचरो, which is probably the correct reading.

सूतुना सिंहगुप्तस्य रसरब्रसमुच्चयः ।
 रसोपरसलोहानि यन्वादिकरणानि च ॥
 शुद्धपर्यमपि लोहानां तन्वादिकरणानि च ।
 शुद्धिः सत्त्वं द्रुतिर्भवकरणच्च प्रवक्ष्यते ॥ 8-10.
 हन्ति भक्षणमाचेण पूर्वजन्माघसम्बवम् ।
 रोगसङ्घमशेषाणां नराणां नात्र संशयः ॥ 26.
 यश्च निन्दति सूतेन्द्रं शशीस्तेजः परात्परम् ।
 स पतेन्द्रके घोरे यावल्कल्यविकल्यनाम् ॥ 29.
 पतितो दरदे देशे गौरवाइङ्गिवक्षातः ।
 स रसो भूतले लौनस्सत्त्वेशनिवासिनः ।
 तां सृदं पातनायन्ने चिन्हा सूतं हरन्ति च ॥
89-90.

इति श्रीवैद्यपतिसिंहगुप्तस्य सूनोर्वामटाचार्यस्य
 छतौ रसरब्रसमुच्चये रसोत्पत्तिर्नाम प्रथमोऽध्यायः ।

अथ द्वितीयोऽध्यायः ।

महारसाः ।

- अभ्रवैक्रान्तमाक्षीकविमलाद्रिजसम्यकम् ।
 चपलो रसकश्चेति ज्ञात्वा एषौ सङ्घहेद्रसान् ॥ 1.
 पिनाकं नागमण्डुकं वज्रमित्यभकं मतम् ।
 खेतादिवर्णभेदेन प्रत्येकं तत्त्वतुर्बिधम् ॥ 5.
 खेतं रक्तञ्च पौतञ्च कृष्णमेवं चतुर्बिधम् ॥ 10.
 सुखनिर्मोच्यपत्रञ्च तदभ्यं शस्त्रमीरितम् ॥ 12.
 सचन्द्रिकञ्च किटामं व्योम न यासयेद्रसम् ।
 ग्रसितस नियोज्योऽसौ लोहे चैव रसायने ॥ 13.
 निषन्द्रिकं सृतं व्योम सेव्यं सर्वगदेषु च ।
 सेवितं चन्द्रसंयुक्तं मेहं मन्दानलं चरेत् ॥ 14.
 प्रतसं सप्तवाराणि निक्षिमं काञ्जिकेऽभ्रकम् ।
 निर्दीर्घं जायते नूनं प्रक्षिप्तं वापि गोजले ।
 त्रिफलाक्षयिते चापि गवां दुरधे विशेषतः ॥ 17-18.
 चूर्णाभ्यं शालिसंयुक्तं वस्त्रवहं हि काञ्जिके ।
 निर्यातं मर्हनाइस्त्रावान्याभ्रमिति कथ्यते ॥ 23.

धान्याभ्यं कासमईस्य रसेन परिमहितम् ।

पुष्टिं दशवारेण स्थियते नात्र संशयः ॥ 24.

अथ वैक्रान्तः—

अष्टास्त्रशाष्टफलकः षट्कोणो मस्तुणो गुरुः ।

शुक्रमिश्रितवर्णैश्च युक्तो वैक्रान्त उच्चरं ॥

खेतो रक्तश्च पीतश्च नीलः पारावतच्छविः ।

श्यामलः क्षणवर्णैश्च कर्बुरश्चाष्टधा हि सः ॥ 55-56.

आयुः प्रदश्च बलवर्णकरोऽतिवृष्टः

प्रज्ञाप्रदः सकलदोषगदापहारी ।

दीप्ताग्निकृत् पवित्रमानगुणस्तरस्त्री

वैक्रान्तकः खलु वपुर्बललोहकारी ॥

रसायनेषु सर्वेषु पूर्वग्रस्थः प्रतापवान् ।

वज्रस्थाने नियोक्तव्यो वैक्रान्तः सर्वदोषहा ॥

57-58.

* * वैक्रान्तं वज्राकारं महारसम् ।

विभ्वस्य दक्षिणे वाऽस्ति शूक्तरे वाऽस्ति सर्वतः ।

विक्रामयति लोहानि तेन वैक्रान्तकः स्मृतः ॥

60-61.

वैक्रान्तकाः स्युस्तिदिनं विशुद्धाः

संखेदिताः चारपटूनि दत्त्वा ।

अन्तेषु मूच्चेषु कुलत्थरभा-

नीरेऽथवा कोद्रववारिपक्षाः ॥

कुलत्थकाथसंस्तिवो वैक्रान्तः परिशुद्धति ।

स्त्रियतेऽष्टपुट्टेर्गन्धनिम्बुकद्रवसंयुतः ॥ 67-68.

भस्मीभूतम्तु वैक्रान्तं वज्रस्थाने नियोजयेत् ॥

मोष्मोरटपालाशक्वारगोमूळभावितम् ।

वज्रकन्दनिशाकल्कफलचूर्णसमन्वितम् ।

तल्कल्कं टह्यणं लाक्षाचूर्णं वैक्रान्तसम्भवम् ॥ 70-71.

नवसारसमायुक्तं भेषशृङ्गीद्रवान्वितम् ।

पिण्डितं मूकमूषस्थं धापितस्त्र हठाग्निना ॥ 72.

तचेव पतते सत्त्वं वैक्रान्तस्य न संशयः ॥ 73.

अथ मात्रिकम्—

सुवर्णशैलप्रभवो विशुना काञ्चनो रसः ।

तापौ¹किरातचीनेषु यवनेषु च निर्मितः ॥ 77.

(1) तापौ, a variant in the Poona ed., which also agrees with B. and K.

मात्त्रिकं द्विविधं हैममात्त्रिकलारमात्त्रिकम् ।
 तत्राद्यं मात्त्रिकं कान्यकुलोत्यं स्वर्णसन्निभम् ॥ 80.
 पाषाणवह्लः प्रोक्तस्तारास्थोऽत्यगुणाम्बकः ॥ 81.
 मातुलुङ्गाम्बुगन्धाभ्यां पिष्टं मूषोदरे स्थितम् ।
 पञ्चक्रोडपुटैर्दम्बं स्त्रियते मात्त्रिकं खलु ॥ 84.
 क्षौद्रगन्धवर्वतैलाभ्यां गोमूचेण छृतेन च ।
 कदलौकन्दसारेण भावितं मात्त्रिकं सुहुः ।
 मूषायां मुच्ति धातं सत्त्वं शुख्वनिभं मृदु ॥
89-90.

अथ विमलः—

विमलस्त्रिविधः प्रोक्तो हैमाद्यस्तारपूर्वकः ।
 दृतीयः कांस्यविमलस्तत्त्वान्या स लक्ष्यते ॥ 96.
 वर्तुलः कोणसंयुक्तः स्त्रिघृष्ण फलकान्वितः ॥ 97.
 गन्धाम्लकुचाह्लैषं स्त्रियते दशभिः पुटैः ॥ 100.
 सट्टह्लकुचद्रावैर्मेषशृङ्खासं भक्षना ।
 पिष्टा मूषोदरे लिपः संशोध च निरुद्ध च ॥

(1) Verses 89-90 as also 103-104 occur both in Rasarnava and Rr. by Nág. ; the Poona ed. reads पतते नाच संशयः in the place of प्रयच्छति न संशयः ;

षट्प्रस्त्रकोकिलैर्धातो विमलः सौससन्निभः । ।

सत्त्वं मुच्छति तदयुक्तो रसः स्थाप्तं रसायनः ॥

101-102.

विमलं शियुतोयेन काञ्चीकासौस्टहणैः ।

वज्रकन्दसमायुक्तं भावितं कदलीरसैः ॥

मोक्षकचारसंयुक्तं धारितं मूकमूषगम् ।

सत्त्वं चन्द्रार्कसङ्खाशं प्रयच्छति न संशयः ॥

103-104.

अथ शिलाधातुः—

शिलाधातुर्दिधा प्रोक्तो गोमूचाद्यो रसायनः ।

कर्पूरपूर्वकशान्यस्त्राद्यो दिविधः युनः ॥ 109.

ग्रीष्मे तीव्रार्कतस्मेभ्यः पादेभ्यो हिमभूभृतः ।

स्वर्णरूप्यार्कगर्भेभ्यः शिलाधातुर्दिनिःसरेत् ॥

110-111.

अथ सखकम्—

मयूरकण्ठवच्छायं भाराव्यमतिश्यर्तं ॥ 127.

1) Both the B. and K. MSS. read सौससन्निभः ।

The Pnooa ed. gives a variant श्रीतसन्निभः ।

मयूरतुत्यम्—

रसायनं वमनरेककरं गरज्जं

शिखापहं गदितमव मयूरतुत्यम् ॥ 129.

खकुचद्रावगन्धाश्मटङ्गेन समन्वितम् ।

निरुध्य मूषिकामधे नियते कौकुटैः पुटैः ॥ 132.

सस्यकस्य तु चूर्णन्तु पादसौभाग्यसंयुतम् ।

करञ्जतैलमध्यस्य दिनमेकं निधापयेत् ॥

मध्यस्यमन्धमूषाया¹ धापयेल्कोकिलत्रयम् ।

इन्द्रगोपाकृति चैव सत्त्वं भवति² शोभनम् ॥ 133-134.

निम्बुद्रवाल्पटङ्गाभ्यां मूषामधे निरुध्य च ।

ताम्ररूपं परिधातं सत्त्वं मुञ्चति सस्यकम् ॥ 135.

शुद्धं सत्त्वं शिखिकान्तं³ पूर्वभेषजसंयुतम् ।

नानाविधानयोरेन सत्त्वं मुञ्चति निश्चितम् ॥ 136.

(1) The Poona ed. reads अन्धमूषाल्पस्यमध्यस्यम् । We have adopted the reading of Rasárnavā.

(2) पतीत, another reading in the Poona ed., which also agrees with B. K. and Rasárnavā.

(3) The Poona ed. reads शिखाकान्तम् ।

अथ चपलः—

गौरः श्वेतोऽरणः कृत्यापलसु चतुर्विधः ।

हेमाभैव ताराभो विशेषाद्रसबन्धनः ॥ 143.

शेषौ तु मध्यौ लाक्षावच्छौभ्रद्रावौ तु निष्कलौ ।

वक्ष्वद्वते वङ्गौ चपलस्तेन कौर्त्तिः ॥¹ 144.

चपलः स्फटिकच्छायः षडःस्तः² स्त्रिघको गुरः ॥
146.

अथ रसकः—

रसको हिविधः प्रोक्तो दुर्दुरः कारवेषकः ।

सदलो दुर्दुरः प्रोक्तो निर्दिलः कारवेषकः ॥ 149.

खर्परः परिसन्तसः समवारं निमज्जितः ।

बौजपूररसस्यान्तनिम्बलत्वं समश्रुते ॥

द्रुमूत्रे वाञ्छमूत्रे वां तक्रे वा काञ्चिकेऽथवा ।

प्रताप्य मज्जितं सम्यक् खर्परं परिशुद्धति ॥ 154-155.

Slokas 143 and 144 are from Rasarnava.

(2) षडः, another reading in the Poona ed. which we have adopted. Slokas 143-146 are evidently borrowed with slight modifications from Rasarnava, VII. 26-27.

हरिद्रात्रिफलारालसिन्धुभूमैः सटङ्गैः ।
 सारुक्करैश्च पादांशैः सार्वैः समर्थ्य खर्परन् ॥
 लिप्तं हन्ताकमूषायां शोषयित्वा निरुद्ध च ।
 मूषां मूषोपरि⁽¹⁾ न्यस्य खर्परं प्रधमेत्ततः ॥
 खर्परं प्रहृते ज्वाला भवेन्नीला सिता यदि ।
 तदा सन्दंशतो मूषां घृत्वा कृत्वा त्वधोमुखौम् ।
 शनैरास्फालयेन्द्रूमौ यथा नालं न भज्यते ॥
 वङ्गाभं पतितं सत्त्वं समादाय नियोजयेत् ॥

157-161.

लाक्षागुडामुरीपथ्याहरिद्रासर्ज्जटङ्गैः ।
 सम्यक्षचूर्णं तत्पक्वं गोदुरधेन घृतेन च ।
 हन्ताकमूषिकामध्ये निरुद्ध गुटिकाकृति ।
 आत्वा आत्वा समाकृष्ट ठालयित्वा शिलात्तजे ।
 सत्त्वं वङ्गाकृति याह्वां रसकस्य मनोहरम् ॥

163-164.

(1) मूषां मूषोपरि, a variant in the Poona ed., which also agrees with B. and K.

यहा जलयुतां स्थालीं निखनेल्कोष्ठिकोदरे ।
 सच्छिद्रं तम्भुखे मझं तम्भुखेऽधीमुखं¹ क्षिपेत् ।
 मूषीपरि शिखित्रांश्च प्रक्षिप्य प्रधमेहृढम् ।
 पतितं स्थालिकानीरे सत्त्वमादाय योजयेत् ॥

165.-166.

तत्सत्त्वं तालकोपेतं प्रक्षिप्य खलु खर्परे ।
 मईयेहोहृदण्डेन भस्मीभवति निश्चितम् ॥ 167-168.

अथ टृतीयोऽध्यायः ।

अथोपरसाः साधारणरसात् ।

अथ गन्धवाः—

गन्धाश्लगैरिकासौसकाक्षीतालशिलाच्छनम्
 काङ्गुहचेत्युपरसासाष्टौ पारदकर्मणि ॥ 1.

(1) तम्भुखेऽधीमुखं. a variant in the Poona ed., which we have adopted.

स चापि निविधो देवि शुकचञ्चुनिभो वरः ।
 मध्यमः पौतवर्णः स्थाच्छुक्लवर्णोऽधमः प्रिये ॥ 12.
 चतुर्द्वा गन्धको ज्ञेयो वर्णः खेतादिभिः खलु ।

* * * * *

दुर्लभः क्षणवर्णस्व स जरामृत्युनाशनः ॥ 13-15.
 गन्धको द्रावितो भृङ्गरसे निस्तो विशुद्धति ॥ 23.
 स्थाल्यां दुग्धं विनिक्षिप्य मुखे वस्त्रं निरुद्ध च ।
 गन्धकं तत्र निक्षिप्य चूर्णितं सिकताकृति ।
 छादयेत्पृथुदीर्घेण खर्परेणैव गन्धकम् ॥
 ज्वालयेत्खर्परं स्थोर्हुं वनच्छाणैस्तथोपलैः ।
 दुग्धे निपतितो गन्धो गतिः परिशुद्धति ॥ 24-25.

अथ गैरिकम्—

पाषाणगैरिकच्चैकं द्वितीयं स्वर्णगैरिकम् ।
 पाषाणगैरिकं प्रोक्तं कठिनं ताम्बवर्णकम् ॥ 46.
 गैरिकम्तु गवां दुग्धैर्भावितं शुद्धिमृच्छति ॥ 49.

अथ कासीसम्—

कासीसं बालुकायेकं पुष्पपूर्वमयापरम् । 51.
 तुवरीसस्ववस्त्वमेतस्यापि समाहरेत् ॥ 54.

अथ तुवरी—

सौराष्ट्रश्मनि समूता¹ भृत्या सा तुवरी मता ।

वस्त्रेषु लिप्यते यासौ मञ्जिष्ठारागबन्धिनी ॥

* * * फुलिका चेति द्वितीया परिकीर्तिता ।

पूर्णत्वीता गुरुस्त्रिघा * * *

निर्भारः शुभ्रवर्णा च त्रिघा मास्त्रापरा मता ।

भा कुम्भतुवरी प्रोक्ता लिपात् तास्त्रं चरेदयः ॥ ६३-६२

काशी कषाया कटुकाम्लकण्ठग्रा

कृश्या वण्णी विषनागनी च ।

त्रिखलावङ्गा विवहिता विदोष-

गान्तिनदा पारदजारणी च ॥ ६३

तुवरी काञ्जिरं त्रिभा विदिनाच्छुद्धिमृच्छति ।

क्षाराम्लैर्मर्दिता धाता सत्त्वं मुच्चति निश्चितम् ॥ ६४.

गोपित्तेन ग्रतं वारान् सौराष्ट्रीं भावयेत् ततः ।

धमित्वा पातयेत् सत्त्वं क्रामणं चातिगुच्छकम् ॥ ६५.

(1) सौराष्ट्रश्मनि, a variant in the Poona ed., which also agrees with B. and K.

अथ तालकम्—

हरितालं हिधा प्रोक्तं पद्मास्यं पिण्डसंज्ञकम् ।
 स्वर्णवर्णं गुरु स्त्रियं ततुपत्रं च भासुरम् ॥ 66.
 स्त्रियं कुञ्जारुतोये वा तिलचारजलेऽपि वा ।
 तोये वा चूर्चसंयुक्ते दोलायन्त्रेण शुभ्यति ॥ 69.
 मधुतुष्णे घनीभूते कषाये ब्रह्ममूलजे ।
 विवारं तालकं भावं पिष्ठा मूर्चेऽय माहिषे ॥
 उपलैद्यभिर्देयं पुटं रक्षाय पेषयेत् ।
 एवं इादशधा पाण्यं शुचं योगेषु योजयेत् ॥ 74-75.
 पलालकं रवेदुर्ग्वैर्दिनमेकं विमर्दयेत् ।
 निष्ठा ओड़ग्निकातैसे मिश्रवित्वा ततः पचेत् ॥
 अनावृतप्रदेशे च सप्तयामावधि ध्रुवम् ।
 स्वाङ्गशीतमधःस्यं च सत्त्वं श्वेतं समाहरेत् ॥ 80-81.

अथ मनःशिला—

अष्टमांशेन किष्टेन गुड़गुमुलुसपिंषा ।
 कोष्ठां रक्षा दृढ़ं खात्वा सत्त्वं मुच्चेन्नमःशिला ॥ 95.

(1) The Poona ed. reads पद्मास्यं and K. reads पद्मास्यं, which we have adopted.

अथाच्छनानि—

सौवीरमच्छनं प्रोक्तं रसाच्छनमतः परम् ।
 स्त्रोतोऽच्छनं तदन्यच्च मुष्माच्छनकमेव च ॥
 नौलाच्छनं च तेषां हि व्यरूपमिह वर्णते ।
 सौवीरमच्छनं धूमं रक्तपित्तहरं हिमम् ॥ 98-99.
 अच्छनानि विशुद्धनि भृङ्गराजनिजद्रवैः ।
 मनोऽग्नासच्चवत् सत्त्वमच्छनानां समाहरेत् ॥
 वस्त्रीकशिखराकारं भङ्गे नौलोत्पत्तयुति ।
 दृष्टं तु गैरिकच्छायं स्त्रोतोजं लक्षणेऽधः ॥
 गोभ्रजादरसमूव्रेषु दृष्टचौद्रवसासु च ।
 भावितं बहुशस्त्रच्च गौव्रं बध्नाति सूतकम् ॥ 105-107

अथ कहुठम्—

हिमवत्यादशिखरे कहुठसुपज्ञायते । 109.
 केचिददन्ति कहुठं सद्योजातस्त्र दन्तिनः । 111.
 वदन्ति श्वेतपीतामं तदतीवर्विरेचनम् । 112.

अथ साधारणरसाः—

कम्भिरस यत्रो गोरोपाषाषो नवसारकः ।
 कपदीं वङ्गिजारस गिरिसिन्दूरहिङुलो ॥

मृहारश्चामित्यष्टौ साधारणरसाः स्मृताः ।

रससिद्धिकराः प्रोक्ता नागार्जुनपुरःसरैः ॥ 120 121.

अथ कम्पिङ्गः—

इष्टिकाचूर्णसङ्घाशसन्दिकाक्षीऽतिरेचनः ।

सौराश्रद्धेशे चोत्पन्नः स हि कम्पिङ्गकः स्मृतः ॥ 122

अथ गौरीपाषाणः—

स्फटिकाभस्थ शङ्खाभो हरिद्राभस्थयः स्मृताः ।

तालवदाहयेत् सत्वं शुद्धं शुभं प्रयोजयेत् ॥ 124-126

अथ नवसारः—

करीरपीजुकाषेषु पच्यमानेषु चोद्धवः ।

चारोऽसौ नवसारः स्याच्चूलिकालवणाभिधः ॥

इष्टिकादहने जातं पाण्डुरं लवणं लघु ।

तदुक्तं नवसाराख्यं चूलिकालवणं च तत् ।

रसेन्द्रजारणं लोहद्रावणं जठरानिकृत् ॥

गुल्मीहास्यशोषज्ञं भुक्तमांसादिजारणम् ॥ 127 129.

अथ वराटकाः—

पौताभा यन्त्रिका पृष्ठे दीर्घवृत्ता वराटिका ।

रसवैद्यर्विनिर्दिष्टा सा चराचरसंचिका ॥ 130.

वराटा: काञ्जिके स्त्रिना यामाच्छुहिमवाप्नुयः ॥ 134 ॥

अथाग्निजारः—

समुद्रेणाग्निनक्षयं जरायुर्वहिरजिङ्गतः ।

संशुष्को भागुतापेन सोऽग्निजार इति सूतः ॥ 135 ॥

अथ गिरिसिन्दूरम्—

महागिरिषु चाल्यायः पाषाणान्तः स्थितो रसः ॥ 137 ॥

अथ हिङ्गुलः—

एतस्मादाहृतः सूतो जौर्णगन्धसमो गुणैः ॥ 141 ॥

दरटः पातनायन्ते पातितश्च जलाशये ।

तत्त्वं सूतसङ्खाशं पातयेनात्र संशयः ॥ 144 ॥

अथ मृद्घारशृङ्गकम्—

सदलं पौतवर्णं च भवेदगुर्जरमण्डले ।

अर्बुदस्य गिरेः पाञ्चें जातं मृद्घारशृङ्गकम् ॥

सीससत्त्वं गुरु श्वेषशमनं पुंगदापहम् ।

रसबन्धनमुत्क्षर्टं केशरञ्जनमुत्तमम् ॥

साधारणरसाः सर्वे मातुलुङ्गार्द्धकाम्बुना ।

विराचं भाविताः शुष्का भवेयुर्दीषवर्जिताः ॥

अथ राजावर्त्तः—४

राजावर्त्तोऽल्परक्तोहनीसिमभिश्चितप्रभः¹ । 149.

लुङ्घाम्बुगन्धकोपेतो राजावर्त्तो विचूर्णितः ।

पुटनास्त्रसवारेण राजावर्त्तो मृतो भवेत् ॥ 153.

अथ चतुर्थोऽध्यायः ।

अथ रत्नानि ।

मरुयः—

मणयोऽपि च विज्ञेयाः सूतबन्धस्य कारकाः ।

वैक्रान्तः सूर्यकान्तय हीरकं मौक्तिकं मणिः ॥

चन्द्रकान्तस्तथा चैव राजावर्त्तस्य सप्तमः ।

गद्धोऽग्नारकसैव ज्ञातव्या मरुयस्वमौ ॥

(1) नौक्रमाभिश्चितप्रभः, another reading in the Poona ed., which agrees with B. and K., but it is grammatically inaccurate.

पुष्परागं महानौलं पद्मरागं प्रबालकम् ।
वैदूर्यं च तथा नीलमेति च मणयो मताः ॥

33.

अथ वज्रम्—

वज्रं च त्रिविंशं प्रोक्तं नरो नारी न पुंसकम् ।
पूर्वं पूर्वमिह शेषं रसवीर्यविपाकतः ॥ 26.
अष्टास्त्रं चाष्टफलकं षट्कोणमतिभासुरम् ।
अग्नुदेन्द्रधनुर्वारितरं पुंवज्रमुच्छते ॥ 27.
तदेव चिपिटाकारं स्त्रौवज्रं वर्तुलायतम् ।
वर्तुलं कुण्डकोणायं किञ्चिहुरु न पुंसकम् ॥ 28.
खेतादिवर्णमेदेन तदेकैकं चतुर्विधम् ।
ब्रह्मचन्त्रियविटशूद्रं स्त्रौवर्णफलप्रदम् ॥ 30.
आयुःप्रदं भट्टिति सहुणदं च हृष्णं
दोषवयप्रशमनं सकलामयज्ञम् ।
सूतेन्द्रबन्धवधसहुणकृत् प्रदौपं
मृत्युञ्जयं तदमृतोपममेव वज्रम् ॥ 32.
कुलत्यक्तायके स्त्रियं कोट्रवक्षयितेन वा ।
एकयामावधि स्त्रियं वज्रं शुद्ध्यति निषितम् ॥

वज्रं मत्कुणरक्तेन चतुर्वारं विभावितम् ।

सुगन्धिमूषिकामांसैर्वर्त्तिंतः परिवेष्य च ॥

पुटेत् पुटैर्वराहाख्यैस्त्रिंशद्वारं ततः परम् ।

धात्वा धात्वा शतं वारान् कुलत्यकाथके द्विपेत् ॥

अन्यैरुक्तः शतं वारान् कर्त्तव्योऽयं विधिक्रमः ॥ 34-37.

कुलत्यकाथसंयुक्तालकुचद्रवपिण्ड्या ।

शिलया लिप्समूषायां वज्रं द्विष्ठा निरुद्ध्य च ।

अष्टवारं पुटेत् सम्यन्विशुर्कैश्च वनोपलैः ।

शतवारं ततो धात्वा निद्विसं शुद्धपारने ।

निद्वितं नियते वज्रं भस्म वारितरं भवेत् ॥ 38-39.

सत्यवाक् सोमसेनानीरेतद्रवज्जस्य मारणम् ।

दृष्टप्रत्ययसंयुक्तमुक्तवान् रसकौतुकी ॥ 40.

विलिसं मत्कुणस्यास्ते सप्तवारं विशोषितम् ॥

कासमर्दरसापूर्णे लोहपात्रे निवेशितम् ।

सप्तवारं परिधातं वज्रभस्म भवेत् खलु ॥

ब्रह्मज्योतिर्मनीन्द्रेण क्रमोऽयं परिकौर्त्तिः । 41-43

(1) परिमयं च, another reading in the Poona ed.
which does not agree with B. and K.

मदनस्य फलोऽहूतरयेन क्षीणिनागकैः ।
 छतकल्केन संलिप्य पुटेहिंश्चतिवारकम् ॥
 वज्रचूर्णं भवेद्वर्यं योजयेच्च रसादिषु ॥ 44 45.

अथ रद्धभस्मकमः—

लकुचद्रावसंपिण्ठैः शिलागन्धकतालकैः ।
 वज्रं विनात्यरद्रानि मियन्तेऽष्टपुटैः खलु ॥ 63.
 रामठं पञ्चलवणं क्षाराणां त्रितयं तथा ।
 मांसद्राव्यास्त्रवेतश्च चूलिकालवणं तथा ॥
 स्थूलं कुम्भीफलं पक्वं तथा ज्वालामुखी शुभा ।
 द्रवन्ती च रुदन्ती च पयस्या चित्रमूलकम् ॥
 दुग्धं सुद्धास्तथार्कस्य सर्वं संमर्द्य यन्नतः ।
 गोलं विधाय तन्मध्ये प्रक्षिपेत् तदनन्तरम् ॥
 गुणवत्त्वरद्रानि जातिमन्ति शुभानि च ।
 भूर्जं तं गोलकं कृत्वा सूचेणावेष्य यन्नतः ॥

(1) मांसद्राव्यास्त्रवेतश्च, a variant in the Poona ed., which we have adopted and which also agrees with B. and K.

पुनर्वस्त्रेण संवेष्य दोलायन्ते निधाय च ।
 सर्वाम्लयुक्तसम्भानपरिपूर्णघटोदरे ॥
 अहोरात्रवयं यावत् स्वेदयेत्सौब्रवङ्गिना ।
 तस्मादाहृत्य सङ्खार्य रबजां द्रुतिमाहरेत् ॥ 64-69.
 मुक्ताचूर्णन्तु सप्ताहं वेतसाम्लेन मर्दितम् ।
 जग्मीरोदरमध्ये तु धात्यराशौ विनिच्छिपेत् ॥
 सप्ताहादुदृतचैव पटे दत्त्वा द्रुतिं हरेत् ॥ 70-71.
 वश्ववस्त्रगतरस्यच्च क्षत्वा वज्रं निरोधयेत् ।
 अम्लभाण्डगतं स्वेदयं सप्ताहाद्वतां ब्रजेत् ॥ 72.

अथ वैक्रान्तम्—

श्वेतवर्णन्तु वैक्रान्तमम्लवेतसभावितम् ।
 सप्ताहाद्वाद० सन्देहः खरघर्षम् द्रवत्यलम् ॥ 73.
 केतकीम्वरसो याद्वाः सैन्धवं स्वर्णपुष्पिका ।
 इन्द्रगोपकसंयुक्तं सर्वं भाण्डे विनिच्छिपेत् ॥
 सप्ताहं स्वेदयेदस्मिन् वैक्रान्तं द्रवतां ब्रजेत् ॥ 74-75.

(1) द्रुतिं हरेत्, a variant in the Poona ed., which we have adopted.

अथ पञ्चमोऽध्यायः ।

अथ लोहानि ।

अथ हेमगुणः—

शुद्धं लोहं कनकरजतं भागुलोहाश्मसारं
 पूतीलोहं द्वितयमुदितं नागवज्ञाभिधानम् ।
 मिश्रं लोहं द्वितयमुदितं पित्तलं कांस्यवर्तं
 धातुर्लोहे लुह इति मतः सोऽप्यनेकार्थवाची¹ ॥ 1.
 प्राकृतं सहजं वङ्गिसभूतं खनिसभवम् ।
 रसेन्द्रवेधसज्जातं स्वर्णं पञ्चविधं सृतम् ॥ 2.
 सौख्यं वौथं बलं हन्ति रोगवर्गं करोति च ।
 अशुद्धं न सृतं स्वर्णं तस्माच्छुद्धं समाचरेत् ॥ 11.
 सुवर्णपत्रं तनु कर्षमानं²
 ग्रावरुद्धं पटुधातुयक्तम् ।

(1) सोऽप्यनेकार्थवाची, a variant in the Poona ed., which we have adopted.

(2) सुवर्णपत्रं तनु कर्षमानं, another reading in the Poona ed., which we have accepted.

अङ्गारसंस्थं प्रहराईमानं

धानेन तत् स्याद्वनु पूर्णवर्णम् ॥ 12.

लोहानां मारणं शेषं सब्बेषां रसभस्माना ।

मूलौभिर्मध्यमं प्राहुः कनिष्ठं गन्धकादिभिः ॥ 13.

अरिलोहेन लोहस्य मारणं दुर्गुणप्रदम् ।

क्षत्वा कण्टकविधानि स्वर्णपत्राणि लेपयेत् ।

लुङ्घाक्षुभस्मसूतेन मियते दशभिः पुटैः ॥ 14.

द्रुते विनिक्षिपेत् स्वर्णे लोहमानं सृतं रसम् ।

विचूर्खं लुङ्घतोयेन दरटेन समन्वितम् ॥

जायते कुङ्घमच्छायं स्वर्णं हादशभिः पुटैः ॥

15-16.

हेत्वः पादं सृतं सृतं पिष्टमस्तेन केनचित् ।

पत्रे लिप्त्वा पुटैः पाच्यं दशभिः² मियते ध्रुवम् ॥ 17.

(1) पृष्ठवर्णम्. a different reading in the Poona ed., which we have retained

(2) पुटैः पाच्यं दशभिः, a variant in the Poona ed., which we have adopted.

अथ रजतम्—

सहजं खनिमञ्जातं कृतिमं च चिधा मतम् ॥^{22.}
 नागेन टङ्गणीनैव वापितं शुद्धिमृच्छति ।
 खर्परे भस्मचूर्णाभ्यां परितः पालिकां चरेत् ॥
 तत्र रूप्यं विनिक्षिप्य समसीससमन्वितम् ।
 जातमीसक्तयं यावद्भित् तावत् पुनः पुनः ॥
 इत्थं सगोधितं रूप्यं योजनीयं रसादिषु । 32-34.
 लकुचद्रवप्रताभ्यां तारपत्रं प्रज्ञेपयेत् ॥
 ऊर्ध्वाधो गच्छकं दा सूषामध्ये निरुद्ध्य च ।
 स्वेदयेषालुक्तायज्ञे उड्डनैकं छट्ठायनिना ॥
 स्वाङ्गशीतां च तां पिण्डिं मास्तानेन महिताम् ।
 पुण्ड्रेहादगवाराणि भस्मीभवति रूप्यकम् ॥

35-37.

मात्रीकचूर्णलुङ्घान्तमहितं पुष्टितं शनैः ।
 चिंशद्वारेण तत् तारं भस्मसाज्जायतेतराम् । 38.

(1) च चिधा, another reading in the Poona ed., which also agrees with B. and K.

तारपञ्चं चतुर्भागं भागैकं शुच्चतालकम् ।
 मर्द्योऽजम्बीरजद्रावैस्तारपचाजि लेपयेत् ॥
 शोषयेदन्धयन्ते च चिंशदुपलकैः पचेत् ।
 चतुर्द्वयपुट्टेरवं निरुत्यं जायते ध्रुवम् ॥ 40-41

अथ ताम्रम्—

म्लेच्छं नेपालकं चेति तयोर्नेपालमुत्तमम् ।
 नेपालादन्धखन्युत्थ म्लेच्छमित्यभिधीयते ॥ 44.
 जम्बीररससंपिष्ठरसगन्धकलेपितम् ।
 शुखपञ्चं शरावस्थं त्रिपुट्टेर्याति पच्चताम् ॥ 55

अथायः—

मुण्डं तौश्णं च कान्तं च त्रिप्रकारमयः सृतम् ।

अथ मुण्डम्—

मृदु कुण्डं कडारं च त्रिविधं मुण्डमुच्यते ॥ 70.
 द्रुतद्रावमविस्फोटं चिक्कणं मृदु तच्छुभम् ।
 हतं यत्प्रसरेद्दुखात् तत्कुण्डं मध्यमं सृतम् ॥
 यहतं भज्यते भङ्गे क्षणं स्थात्त्वाडारकम् ॥ 71 72.

(1) The Poona ed. reads मर्द्य, which is grammatically inaccurate.

अथ तीक्ष्णम्—

* * * षड्विधं तीक्ष्णमुच्यते ॥ 75.

परुषं पोगरोमुक्तं भङ्गे पारदवच्छवि ।

नमने भङ्गुरं यत् तत् खरलोहमदाहृतम् ॥ 76

वेगभङ्गुरधारं¹ यत् सारलोहं तदीरितम् । 78.

अथ कान्तम्—

भ्रामकं चुम्बकं चैव कर्षकं द्रावकं तथा ।

एवं चतुर्विधं कान्तं रोमकान्तं च पञ्चमम् ॥

एकहितिचतुःपञ्चसर्वतोमुखमेव तत् ।

पौतं क्षणं तथा रक्तं त्रिवर्णं स्यात् पृथक् पृथक् ॥

84-85.

भ्रामयेष्ठोहजातं तु तत् कान्तं भ्रामकं मतम् ॥

चुम्बयेषुम्बकं कान्तं कर्षयेत् कर्षकं तथा ।

साक्षादयद्वावयेष्ठोहं तत् कान्तं द्रावकं भवेत् ॥

तदरोमकान्तं स्फुटिताद्यतो रोमोहमो भवेत् ।

88-89.

मदोमत्तगजः सूतः कान्तमङ्गुशमुच्यते ॥

(1) The Poona ed. reads वेगभङ्गुरधारम्, which is grammatically inaccurate

नेत्रं खात्वा ग्रहीतव्यं तद्ययन्नेन धीमता ।
 मारुतातपविक्षिप्तं वर्जयेद्भात्र संशयः ॥ १२-१३.
 पात्रे^१ यस्य प्रसरति जले तैलबिन्दुर्न लिप्तं
 गन्धं हिङ्गु त्यजति च तथा तिक्ततां निष्ककल्पः ।
 पार्क दुग्धं भवति शिखराकारकं^२ नैति भूमिं
 कान्तं लोहं तदिदमुदितं लचणोक्तं न चान्यत् ॥ १४.
 श्रितिं धृतमयुक्तं चिष्ठायः खर्परं पचेत् ।
 चालयेत्ते।हृदगडिन यावत् चिसं लृणं दहेत ॥
 पिष्ठा पिष्ठा पचेदेवं पञ्चवारमतः परम् ।
 धार्मीफलरसैर्यद्वा तिफलाक्रयितोदकैः ।
 पुट्टेभ्यः चतुर्दर्शं भवेद्वारितरं खलु ॥ १०४-१०५

(1) Cf. यत्पात्रं न प्रसरति जलं तैलबिन्दुः प्रतमे
 हिङ्गुर्गन्धं त्यजति च । न तं तिक्ततां निष्ककल्पः ।
 तम् दुग्धं भवात् शिखराकारकं नैति भूमिं
 काण्डाङ्गः स्यात् मजलचणकः कान्तलोहं तदुक्तम् ॥
 भावप्रकाशे कान्तलोहप्रकरणम् ।

(2) A variant in the Poona ed., which
agrees with the भावप्रकाश, as quoted in the foot note.

तोस्यस्तोऽस्त पत्राणि निर्देशानि हृदेजसे ।
 धात्वा चिपेष्टसे सव्यः पाषाणोऽसुखसोदरे ॥
 सख्येदगाढनिघटिः स्युक्षया सोऽपारया ।
 तम्भात्^१ स्युक्षखण्डानि रहा महायान्तरे ॥
 धात्वा चिष्ठा जले सम्यक् पूर्ववत् कर्षयेत् स्वलु ।
 तच्चूर्णं सूतगम्भाभ्यां पुटेऽविंश्टिवारकम् ॥
 पुटे पुटे विधातव्यं पिषणं हृदवत्तरम् ।
 एवं भस्मीक्षतं लोहं तत्तद्वरोगेषु योजयेत् ॥

107-110.

जम्बौरैरालनालैर्वा विंशत्यंशेन हिङ्गुलम् ॥
 पिष्ठा रहा पचेष्टोहं तद्वैः पाचयेत् पुनः ।
 चत्वारिंशत्पुटैरेवं कान्तं तौष्णं च मुखकम् ॥
 मियर्तं नात्र सन्देहो दत्त्वा दत्त्वैव हिङ्गुलम् ।

113-115.

शुद्धसूतं हिधा गन्धं खले तु क्षतकज्जलीम् ।
 हयोः समं लोहचूर्णं मर्दयेत् कन्यकाद्रवैः ॥

(1) तम्भात्, a reading in the Poona ed., which also agrees with B. and K.

यामहयात् समुद्रत्य तज्जीलं ताम्बपात्रके ।
 आच्छायैरण्डपचैश्च यामार्देऽत्युष्णता भवेत् ॥
 धान्यराशो व्यसेत् पश्चात् त्रिदिनान्ते समुद्ररेत् ।
 संपेत्य गालयेद्वस्ते सत्त्वं वारितरं भवेत् ॥
 कान्तं तौरां च मुण्डं च निरुत्यं जायते ध्रुवम् ।
 स्वर्णादीन् मारयेटेवं चूर्णं क्षत्वा च लोहवत् ॥

134-137.

लोहकिङ्टं सुसन्तसं यावज्जीर्यति तत् स्वयम् ।
 तच्चूर्णं जायते पेण्यं मण्डूरोऽयं प्रयोज्यते ॥ 147.
 ये गुणा मारिते मुण्डे ते गुणा मुण्डकिङ्टके ।
 तस्मात् सर्वत्र मण्डूरं रोगशान्त्यै प्रयोजयेत् ॥ 148.

अथ वङ्गम्—

सुरकं मिश्रकं चेति द्विविधं वङ्गमुच्यते ।
 खुरं तद्र गुणैः श्रेष्ठं मिश्रकं न हितं मतम् ॥ 153.
 धवलं मृदुलं स्त्रिग्धं द्रुतद्रावं सगौरवम् ।
 निःशब्दं सुरवङ्गं स्यामिश्रकं श्यामशुभ्रकम् ॥ 154.

(1) ताम्बपात्रके, a reading in the Poona ed., which also agrees with B. and K.

वङ्गं तिक्षोष्णवां रुचमीषद्वातप्रकोयनम् ।
 मेहस्तेषामयज्ञं च मेदोज्ञं क्रिमिनाशनम् ॥ 155.
 द्रावयित्वा निशायुते चितं निर्गुण्डिकारसे ।
 विशुध्यति विवारेण सुरवङ्गं न संशयः ॥ 156.
 सतासेनार्कदुग्धेन लिप्ता वङ्गदलाभ्यय ।
 बोधिचिच्छात्वचः चारैर्द्याश्वपुष्टानि च ॥
 मर्दयित्वा चरेङ्गस्म * * * ॥ 159-160.

अथ सौसंक्षम्—

द्रुतद्रावं महाभारं क्षेटे काशसमुज्ज्वलम् ।
 पूतिगन्धं वह्निःकाशं शुद्धं सौसमतोऽन्यथा ॥ 171.
 पश्चविंश्यतिकं नागमधस्तौद्रानसं चिपेत् ।
 द्रुते नागे चिपेत् सूतं शुद्धं कर्षमितं शुभम् ॥
 विघ्न्य निचिपेत् चारमेकैकं हि पसं पश्चम् ।
 अर्जुनस्ताद्वृष्टस्त्र महाराजगिरेत्पि ।
 दाढिमस्त्र मयूरस्त्र चिप्ता चारं शुद्धक् शुद्धक् ॥

(1) चर, a variant in the Poona ed., which also agrees with B. and K.

एवं विश्वतिरावाणि पचेत् तीव्रेण वक्षिना ।
 विघटयन् हृदं दोर्भां सोहृदर्था प्रयत्नतः ॥
 रक्तं तज्जायते भस्म कापोतच्छायमेव वा ।

176 179.

शिलया रविदुर्घेन नागपत्राणि लेपयेत् ॥
 मारयेत् पुटयोगेन निरुत्यं जायते तथा । 184-185.

अथ पित्तलम्—

रौतिका काकतुण्डी च द्विविधं पित्तलं भवेत् ।
 समसा काञ्चिके चिप्ता ताम्बाभा रौतिका मता ॥
 एवं या जायते छाणा काकतुण्डीति सा मता ॥

192-193.

गुर्वीं मृद्दी च पीताभा साराङ्गीः ताढ़नष्ठमा ।
 सुच्छिन्धा मस्तणाङ्गी च रौतिरेताहृशी शुभा ॥ 195.
 पूतिगन्धा तथा लघू रौतिनेष्टा रसादिषु ॥ 196.
 निम्बूरसशिलागन्धवेष्टिता पुष्टिताष्ठधा ।
 रौतिरायाति भस्मत्वं ततो योज्या यथायथम् ॥
 ताम्बवन्धारणं तस्याः छत्वा सर्वं योज्यवेत् ।

201, 202.

अथ कांस्यम्—

अष्टभागेन ताम्रेण हिभागकुटिलेन च ।

विद्वुतेन भवेत् कांस्यं * * * ॥ 205.

नियते गन्धतालाभ्यां निरुत्यं पञ्चभिः पृष्ठैः ॥ 210.

अथ वर्त्सोहम्—

कांस्याकरीतिष्ठोहाहिजातं तद्वर्त्सोहकम् ।

तदेव पञ्चलोहास्थं लोहविद्विहदाहृतम् ॥ 212.

नियते गन्धतालाभ्यां पुष्टितं वर्त्सोहकम् । 216.

अथ षष्ठोऽध्यायः ।

अथ शिष्योपनयनम् ।

आचार्यो ब्रानवान् दक्षो रसशास्त्रविशारदः ।

मन्त्रसिद्धो महाधीरो निष्ठलः शिववल्लः ॥

देवीभद्रः सदाधीरो देवतायागतत्परः ।

सर्वाञ्जायविशेषज्ञः कुरुते रसकर्मणि ॥

एवं लक्षणसंयुक्तो रसविद्यागुरुभवेत् ।
 गुरुभक्ताः सदाचाराः सत्यवन्तो हृष्टव्रताः ॥
 निरालक्षाः स्वधर्मज्ञाः सदाचारपरिपालकाः ।
 दध्माक्षयनिर्मुक्ताः कुलाचारेषु दौचिताः ॥
 अत्यन्तसाधकाः शास्त्रा मन्त्राराधनतत्पराः ।
 इत्येवं लक्षण्युक्ताः शिष्याः स्युः कार्यसिद्धये ॥३-७
 आतहृरहिते देशे धर्मराज्ये मनोरमे ।
 उमामहेश्वरोपेते समृद्धे नगरे यमे ॥ ०
 कर्त्तव्यं साधनं तत्र रसराजस्य धीमता ।
 अत्यन्तोपवने रम्ये चतुर्हारोपशोभिते ॥
 तत्र शाला प्रकर्त्तव्या सुविस्तौर्णा मनोरमा ।
 सम्यग्वातायनोपेता दिव्यचिन्तैर्विचिन्तिता ॥

13-15.

निष्कर्षय हेमपतं रसेन्द्रं नवनिष्कर्म ।
 अन्नेन मर्दयेद्यामं तेन लिङ्गं तु कारयेत् ॥
 तस्मिंशु पूजयेत् तत्र तु यमेष्वपचारकैः ॥
 लिङ्गकोटिसहस्रस यत् फलं सम्यनर्चनाद् ।
 तत् फलं कोटिशुचितं रसलिङ्गार्द्यमभवेत् ॥

तत्त्वहत्यासहस्राचि स्तोगोहत्याबुतानि^१ च ।

तत्त्वचादविशयं यान्ति रससिद्धम् हर्षनात् ॥

19-22.

रसविद्या^२ शिवेनोक्ता दातव्या साधकाय है ।

यद्योक्तेन विधानेन मुहूर्ता मुदितामना ॥ 30.

कोष्ठी मूषा वह्नाली तुषाङ्गारबोपलाः ॥

भस्त्रिका दख्तिकानेकाः शिलाखण्डान्युलूखलम् ।

* * * * *

अनेन मूलमन्त्रे भैरवं तद्र पूजयेत् ।

सर्वेषां रससिद्धानां नाम सहीर्तयेत्तदा ॥

* * * * *

सप्तविंशतिसंख्याका रससिद्धिप्रदायकाः ।

वन्ध्याः पूज्याः प्रयत्नं ततः कुञ्चादूरसार्चनम् ॥

52-61.

(1) खीगोहत्याबुतानि च, a variant in the Poona ed., which we have adopted.

(2) B. and K. read रसदीका ।

हर्षयेहिजटेवानां तर्पयेदिष्टेवताः ।

कुमारौयोगिनीयोगीश्वरान् खेच्छकसाधकान्¹ ॥

62.

रसविद्या इडं गोप्या मातुर्गुच्छमिव भ्रुवम् ।

भवेद्वौर्ध्वती गुप्ता निर्वर्ण्या च प्रकाशनात् ॥⁷⁰

अथ सप्तमोऽध्यायः ।

अथ रसशाला ।

रसशालां प्रकुर्बीति सर्वबाधाविवर्जिताम् ।

सर्वैषधमये देशे रस्यकूपः समन्विते ॥

नानोपकरणोपेतां प्राकारेण सुशोभिताम् ॥

शांखायाः पूर्वदिमागे स्थापयेदरसभैरवम् ।

वक्षिकर्ण्याशि चान्वेत्ये यास्ये पाषाणकर्णं च

(1) खेच्छकसाधकान्, a variant in the Poona ed., which also agrees with B.

(2) रस्यकूप, a variant in the Poona ed., which we have adopted.

नैकर्त्त्वे शस्त्रकर्माणि वाहणे चालनादिकम् ।
 शोषणं वायुकोशे च वेधकम्भीत्सरे तथा ॥
 स्नापनं सिद्धवस्तुनां प्रकृत्यादीशकोषके ।
 पदार्थसङ्घः कार्यी रससाधनहेतुकः ॥
 सस्वपातनकोषीच्च सुराकोषीं सुशोभनाम् ।
 भूमिकोषीं चहल्कोषीं जलाद्रोणीरनेकशः ॥
 भस्त्रिकायुग्मं तद्वक्षलिके वंशलोहयोः ।

* * * *

करणानि विचित्राणि द्रव्याण्यपि समाहरेत् ।
 कण्ठनीं पेषणीं खज्जान् द्रोणीरूपांश्च वर्तुलान् ।
 सूक्ष्मच्छ्रद्धसहस्राक्षां द्रव्यगालनहेतवे ।
 चालनीच्च कटचाणि * * * ॥

मूषान्तुष्टुषकार्पासवनोपलकपिष्ठकम् ।
 काचायोन्दृद्वराटानां कूपिकाचषकानि च । 1-18.
 गिर्लीभाः सत्यवक्तारो देवबाल्लणपूजकाः ।
 यमिनः पञ्चभोक्तारो योजनीया रसायने ॥ 30.
 तत्तद्वौषधनामज्ञाः शुचयो वचनोज्जिताः ।
 नानाविषयभाषाज्ञास्ते भता भेषजाहृतौ ॥ 32.

अथ अट्टमोऽध्यावः ।

अथ परिभाषा ।

कथं सोमदेवेन मुखवैष्णवदुहवे ।

परिभाषा रसेन्द्रस्य शास्त्रैः विद्वै भाषिता ॥ १.

अहं सिंहरसस्य तेजस्तयोर्लोहस्य भागोऽष्टमः

संसिद्धाखिललोहचूर्णवटकादीनां तथा सप्तमः ।

यो दीयेत भिषम्बराय गदिभिर्निर्दिश्च धन्वन्तरिं

सर्वारोग्यमुखाप्तये निगदितो भागः स धन्वन्तरः ॥ २.

धातुभिर्गन्वकाद्यैष निर्देवैमर्दितो रसः

सुश्लक्षणः कञ्जकाभोऽसौ कञ्जसौत्कंभिधौयते ॥

सद्गवा मर्हिता संव रसपह इति सूतः ॥ ३-६.

सूतं तरति यज्ञोये लोहं वारितरं हि तत् ।

चक्रुष्टतर्जनीष्टुष्टं यत्तदूरेषाम्नातरं विशेष् ॥

सूतं लोहं तदुष्टिष्टं रेखापूर्णभिधानतः ॥

(1) रमान्तरं, a variant in the Poona ed. which we have adopted.

गुणगुच्छासुखसर्गमध्वाज्यैः¹ सह योजितम् ।
 नायाति प्रकृतिं धानादपुनर्भवमुच्यते ॥
 तस्मोपरि गुरु द्रव्यं धान्यं चोपनयेदभुवम् ।
 हंसवत् तौर्यते वारिश्चुत्तमं परिकीर्तितम् ॥

25-28.

रौप्येण सह संयुक्तं धातं रोप्ये² न चेष्टगेत् ।
 तदा निरत्यमित्युक्तं लोहं तदपुनर्भवम् ॥ 29.
 तौश्चं नीलाञ्जनोपेतं धातं हि बहुशो दृढम् ।
 मृदुक्षणं दृतद्रावं वरनागं³ तदुच्यते ॥ 38.

(1) Cf. दृतमधुगच्छाटकैः समं लोहमन्म नटयेष विच्चयः ।
 धमिदवङ्गौ यदा पुनर्लोहमावं न गच्छेत् तदा योज्यं रसायने ॥
 लोहमावं यदा गच्छेत् तं पुनर्लोहयन् सधीः ।
 रमचन्द्रिका जारथमारथाभ्यायः ।

(2) We have adopted the reading in B. and K. The Poona ed., however, reads रौप्येष चेष्टगेत्, which, from the chemical point of view, is untenable.

(3) वरनागं, a variant in the Poona ed., which also agrees with B.

सूतस्य पुनरुद्धृतिः सम्प्रोक्तोत्यापनाख्यया । 39.

इयमानस्य सूतस्य भोज्यद्रव्याभिका मतिः ।

इयतीत्युच्चते यासो यासमानमितीरितम् ॥ 64.

चतुःषष्ठ्यं यतो वौजप्रक्षेपो मुखमुच्चते ।

एवहृते रसो यासलोलुपो मखवान् भवेत् ॥

कठिनात्यपि लोहानि चमो भवति भक्षितुम् ॥ 68-69.

लेपः देपस्य कुन्तश्च धूमाख्यः शब्दसंज्ञकः ।

लेपेन कुरुते लोहं स्वर्णं वा रजतं तथा ॥ 80.

वझौ धूमायमानेऽन्तः प्रक्षिप्तरसधूमतः

स्वर्णायापादनं लोहे धूमवेधः स ईरितः ॥ 83.

मुखस्थितरसेनाख्यलोहस्य दमनात् खलु ।

स्वर्णरूप्यत्वजननं शब्दवेधः स कीर्तितः ॥ 84.

रसनिगममहाव्यः सीमदेवः समन्तात्

स्फुटतरपरिभाषानामरदानि हृत्वा ।

व्यरचयदतियदात् तैरिमां कण्ठमासां

क्षमयतु । भिषगद्यगो मण्डनार्द्दं सभायाम् ॥ 89.

(1) क्षमयतु, another reading in the Poona ed., which we have adopted.

अथ नवमोऽध्यायः ।

अथ यन्माणि ।

अथ यन्माणि वस्त्रन्ते रसतन्माण्यशेषतः ।

समालोक्य समासेन सोमदेवेन साम्भ्रतम् ॥ 1.

अथ दोलायन्मम्—

इवद्रव्येण भाण्डस्य पूरिताहींदरस्य च ।

मुखमुभयतो हारदयं क्षत्वा प्रथन्तः ॥ 3.

तयोसु निक्षिपेददण्डं तथाधे रसपोटखीम् ।

बहा तु स्वेदयेदेतददोलायन्ममिति च्छृतम् ॥ 4.

अथ स्वेदनीयन्मम्—

साम्बुद्ध्यालौमुखाबहे वस्त्रे पाक्यं निवेशयेत् ।

पिधाय पच्यते यद स्वेदनीयन्ममुच्यते ॥ 5.

अथ पातनायन्मम्—

अष्टाङ्गुलपरिणाहमानाहेन दशाङ्गुलम् ।

चतुरङ्गुलकोक्तेऽधं तोयाधारं गत्तादधः ॥

अधीभाण्डे मुखं तस्य भाण्डस्योपरिवर्त्तिः ।

पीडशाङ्गुलविस्तौर्णपृष्ठस्यास्ये प्रवेशयेत् ॥

पार्श्वयोर्भिष्वीकौरचूर्णमण्डूरफाचितः ।

सिंहा विशेषयेत् सन्धिं जलाधारे जलं चिपेत् ।

तुष्टगामारोपयेदेतत् पातनायन्नमीरितम् ॥ 6-8.

अथाधःपातनायन्नम्—

अथोर्भाजने¹ लिङ्गं स्थापितस्य जले चुधौः ।

दौसैर्वनोपद्यैः कुर्यादधःपातं प्रयत्नतः ॥ 9.

अथ दीपिकायन्नम्—

कञ्चपयन्नान्तर्गतमृद्यपौठस्यदीपिकासंखः ।

यस्मिन्निपतति सूतः प्रोक्तं तद्दीपिकायन्नम् ॥ 10.

अथ ढेकीयन्नम्—

भाग्णकण्ठादधश्चिद्रे वेणुनालं विनिश्चिपेत् ।

कांस्यपाच्छयं कल्पा सम्पुटं जलगर्भितम् ॥

नलिकास्यं तच योज्यं दृढं तद्वापि कारवेत् ।

युतद्रव्यैर्विनिश्चिपः पूर्वं तच घटे रसः ।

अनिना तापितो नालास्तोये तस्मिन् पतन्नधः ॥

यावदुष्णं भवेत्सर्वं भाजनं तावदेव हि ।

आयते रससंधानं ढेकीयन्नमितीरितम् ॥ 11-14.

(1) K. reads चच, which we have retained.

चत्र वासुकायन्त्रम्—

सरसां गृहवक्षां सृदृवस्त्राणुलघनावताम् ।
 शीघ्रितां काचकलसीं पूरयेत् विषु भागयोः ॥
 भार्खे वितमितिगम्भीरे वासुका सुप्रतिष्ठिता ।
 तस्मार्थं पूरयेत् विभिरव्याभिरवगुणयेत् ॥
 भार्खवक्षं माचिकाया सन्धिं सिम्येनृदा पचेत् ।
 चुक्षरां दृष्ट्या चादाहाच्छिकापृष्ठवर्त्तिनः ॥
 एतदि वासुकायन्त्रं तद्यन्तं लवणाश्रयम् ॥34-36.

चत्र लवणयन्त्रम्—

एवं लवणविषेपात् प्रोक्तं लवणयन्त्रकम् । 38.

चत्र नालिकायन्त्रम्—

लोहनालिकतं सूतं भार्खे लवणपूरिते ।
 निरहं विषेपत् प्राम्बद्धालिकायन्त्रमौरितम् ॥ 41

चत्र तिर्यक्पात्रयन्त्रम्—

खिपेदूरसं घटे दीर्घनताधीनालसंयुते ।
 तक्षालं निखिपेदन्तघटकुच्छन्तरे स्तु ॥

(1) दीर्घनताधी, a variant in the Poona ed., which also agrees with B. and K.

तत्र वृद्धा वृद्धा सम्यग्बदने घटयोरधः ।

अधस्तादूरस्कुशस्य च्छालयेत् तीव्रपावकम् ॥

इतरस्मिन् घटे तोयं प्रक्षिपेत् स्वादुभौतकम् ।

तिर्यक्पातनमेतदि वार्त्तिकैरभिधीयते ॥ 48-50.

अथ हिङ्गुलाङ्गुष्ठिविद्याधरयन्वम्—

सात्त्विकोर्परि विन्यस्य स्थासीं सम्युडनिहृष्ट च ।

जर्जुखास्थां जलं चिप्ता वक्षिं प्रच्छालयेदधः ॥

एतद्विद्याधरं यन्म इहिङ्गुलाङ्गुष्ठिहेतवे ॥ 57-58.

अथ धूपयन्वम्—

विधायाष्टाङ्गुलं पात्रं सौहमष्टाङ्गुलोच्छयम् ।

कण्ठाधो इग्नुले देशे गलाधारे हि तत्र च ॥

तिर्यग्लोहश्चलाकाश तन्मौस्तिर्यग्विनिक्षिपेत् ।

तनूनि स्वर्णपत्राणि तासामुपरि विन्यसेत् ॥

पात्राधो निक्षिपेदधूमं वस्त्रमाणमिहैव हि ।

तत् पात्रं व्युत्पातेण च्छादयेदपरेण हि ॥

वृद्धा विश्विष्य सन्धिं च वक्षिं प्रच्छालयेदधः ।

तेन पत्राणि ज्ञात्स्वानि¹ इतान्युक्तविधानतः ॥

(1) ज्ञात्स्वानि, another reading in the Poona ed., which we have accepted.

* * * * *

गन्धालकशिलानां हि कल्पया वा मृताहिना ॥
धूपनं स्वर्णपचाषां प्रथमं परिकीर्तिम् ।
तारायें तारपचाष्णि मृतवज्ज्ञेन धूपयेत् ॥
धूपयेच यथायोग्येरन्यैरपरसैरपि ।
धूपयन्मिदं प्रोक्तं जारणाद्रव्यसाधनम् ॥ 70-76.

अथ दशमोऽध्यायः ।

अथ मूषादिकथनम् ।

मृतिका पाण्डुरख्यूला शर्करा शोणपाण्डुरा ।
चिरासानसहा सा हि मूषार्थमतिशस्यते ॥
तदभावे हि वास्त्रौकी कौलालौ वा समैर्यते ॥
या मृतिका दण्डतुष्टैः शण्डेन
शिखिचक्कर्वा हयलहिना च ।
लोहेन दण्डेन च कुट्टिता सा
साधारणी स्वात् खलु मूषिकार्थम् ॥ 5-6.

(1) सात् and मूषकार्थं are two different readings in the Poona ed., which we have adopted.

अथ पुटानि—

सोहाटेरपुनर्भावो गुणाधिकां ततोऽप्यता ।
 अनप्सु मज्जानं रेखापूर्णता पृष्ठतो भवेत् ॥ 51.
 निम्ने विस्तरतः कुण्डे हिङ्गसे चतुरस्तके ।
 वनोपलसहस्रेण पूरिते पुटनौषधम् ॥
 कोष्ठग्रां⁽¹⁾ रुद्धं प्रयत्नेन पिण्डिकोपरि निष्पित् ।
 वनोपलसहस्रार्द्धं कोष्ठिकोपरि विन्यमेत् ॥
 वङ्गिं प्रज्वालयेत् तच महापुटमिदं स्फृतम् ॥ 54-56.
 सुवर्णं रजतं ताम्रं च पु सौसकमायसम् ।
 षड्हेतानि च लोहानि क्षत्रिमे कांसपित्तले ॥ 70.
 लवण्यानि षड्हेत्वं सामुद्रं सैन्धवं विहृतम् ।
 सौवर्चलं रोमकं च चूलिकालवर्णं तथा ॥
 चारचर्यं समाख्यातं यवसर्जिकटहस्तम् ॥ 71.

 जम्बूकमण्डुकवसा वसा कच्छपसच्चवा ।

(1) कोष्ठग्रां, a variant in the Prona ed.. which we have adopted.

कर्कोटी विषमारी च गोशूकरनरोहणा ।
 अबोइवरमेवाचां महिषम वसा तथा । 76 7-7.
 मूर्चावि इस्तिकरभमहिषीकरवाजिनाम् ।
 मोडजावीनां स्त्रियः पुंसां पुरुषं वीर्यं तु योजवेत् ॥
 78.

चार्देरीवरकालां च अन्तिकं कोलदाढ़िमम् ।
 अम्बुडा तिभिण्डीकं च नारङ्गं रसपत्रिका ।
 करवन्दं तथा चाव्यदग्धवर्गः प्रकौर्तितः ॥
 चणकालय सर्वेषामेक एव प्रशस्यते ॥
 अन्नवेतष्टमिकां वा सर्वेषामुत्तमोत्तमम् ।
 रसादीनां विशुद्धर्थं द्रावणे जारणे हितम् ॥
 कोलदाढ़िमधुचालुनिकाचुक्रिकारसम् ।
 पञ्चालकं समुहिष्टं तञ्चोत्तं चालपञ्चकम् ॥
 80-84.

इष्टिका गैरिका लोखं भस्म वस्त्रौकमृतिका ।
 रसप्रयोगकुशलैः कौर्तिताः पञ्च मृतिकाः ॥ 85.
 शृङ्गीकं चालकूटं च वस्त्रनाभं सज्जचिमम् ।
 पित्तं च विषवर्मोऽयं स वरः परिकौर्तितः ॥ 86.

साहूली विषमुष्टिश्च करवौरजटा तथा ।

नलिकः कमकोऽर्कश्च वर्गे शुपविषाम्बः ॥ 88.

गुडगुमुलुगुच्छान्यसारघैष्टक्षान्वितैः ।

दुद्रावास्त्रिललोहादेद्रावणाय गणो मतः ॥ 100.

अथैकादशीऽध्यायः ।

अथ रसशोधनादिकथनम् ।

रसार्णवादिशास्त्राणि निरीक्ष कथितं मया ।

रसोपयोगि यत्किञ्चिहित्ताचं तत्पदर्शितम् ।

अधुना रसराजस्य संस्कारान् सम्प्रचक्षामै ॥ 10.

विषं वक्षिर्मर्मलखेति दोषा नैसर्गिकास्त्रयः ।

यौगिकौ नागवङ्गौ हौ * * * * ॥ 14-15.

तत्त्वात् सूतविधानार्थं सहायैर्निमुख्युर्युतः ।

सर्वोपस्त्रारभादाय रसकर्मं समाचरेत् ॥ 20.

इ सहस्रे पत्तानां तु सहस्रं शतमेव वा ।

पष्टाविंशत् पलान्ये यज्ञैकमेव वा ॥
 पलाहेनैव कर्तव्यः स यज्ञस्य च ।
 सुदिते शुभनक्षत्रे रसशोऽ ॥ 2122.

रससु पादांशसुवर्णजः

पिष्टीक्षतो गन्धकयोगतः ।

तु स्थांशगन्धैः पुटितः क्रमेण

निर्वीजनामा सकलामयज्ञः ॥ 72.

पिष्टीक्षतैरभ्यकसस्वहेम-

ताराकंकान्तैः परिजारितो यः ।

हतख्वतः षड्गुणगन्धकेन

स वौजबहौ विपुलप्रभावः ॥ 73.

काकोदुम्बरिकाया दुग्धेन सुभावितो हिङ्गुः ।

मर्दनपुटेन विधिना सूतं भस्मौकरोत्येव ॥ 111.

देवदालो हरिक्रान्तामारनालेन पेषयेत् ।

तद्रवेः सतधा सूतं कुर्याम्यर्दितमूर्च्छितम् ॥

तत्सूतं खर्परे दद्याइत्या दत्या तु तद्रवम् ।

शुद्धुपरि पचेचाङ्गा भक्त स्वाहावणोपमम् ॥

श्वासार्गस्य वीजानि तवैरहस्यं छन्येत् ।
 तत्त्वं पारदे देयं मूषायामधरोत्तरम् ॥
 एहाः लघुपुटः पश्चात्तुभिर्भस्तां नवेत् । 114-115.

A HISTORY OF HINDU CHEMISTRY

Volume-II

HISTORY OF HINDU CHEMISTRY

FROM

THE EARLIEST TIMES TO THE MIDDLE OF THE
SIXTEENTH CENTURY A.D.

WITH

SANSKRIT TEXTS, VARIANTS, TRANSLATION
AND ILLUSTRATIONS

BY

DRAUPADI & CHANDRA RAY, D.Sc., Ph.D.

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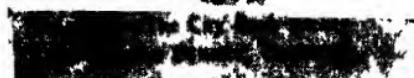
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PREFACE

The second and concluding volume of the *History of Hindu Chemistry* is now presented to the public.

When the first volume was under preparation, it was feared that many valuable works on Hindu Chemistry referred to in *Rasárnava*, *Rasaratna-samuchchaya*, etc., had been lost for ever. Pandit Navakánta Kavibhúshana was deputed to Benares to make a searching enquiry and his labours have been rewarded by the discovery of several rare MSS., including one of *Rasahridaya*. This last-named work is of surpassing interest considering its comprehensiveness and antiquity. Two more transcripts of it have also been procured from the Libraries of the India Office, London, and of the Darbár, Nepal. A copy of *Rásendrá-chúdámani* obtained from the Library of the Deccan College, Poona, has also been of signal help. A critical study of the new materials throws a flood of light on the dark recesses of the history of Indian Chemistry. As a halo of literary and scientific activity including the pursuit of alchemy circles round the prominent figure of Nágárjuna, considerable space has been devoted to a discussion of his age in the Historical Introduction.

It was with diffidence and hesitation that I placed the remotest limit of alchemical *Tantras* in the 14th century A. D. It now transpires that this date is to be pushed back by several centuries.

A *History of Hindu Chemistry* would be rightly regarded as incomplete which did not deal with the constitution of matter and the various hypotheses in regard to it. The European historian of chemistry has always turned his eyes to Greece as the perennial fountain of knowledge on this as on other subjects. And it is but natural that he should do so. * The Hindu atomistic school has not hitherto, I am afraid, found an interpreter who could do full justice to it. Colebrooke's presentation of it with which I had to content myself in the first volume is masterly so far as it goes, but is fragmentary. Not feeling myself equal to the task I applied for help to Mr. Brajendra Náth Seal Principal, Victoria College, Cooch Behar. Principal Seal has kindly responded to my appeal with alacrity. It is to be hoped that a long-felt *desideratum* has at last been supplied.

The frequent references which have been made to the first volume must be taken to mean the second edition of it. Those who happen to possess copies of the first edition will not, however, be put to any serious inconvenience.

* *Vide Vol. 1. Intro. xliii.*

I avail myself of this opportunity to express my cordial thanks to Pandit Hari-chandra Kavi-ratna late Professor of Sanskrit, Presidency College, and my collaborator in the editing of the text of *Rasarnava* in the *Bibliotheca Indica* series.

In the preface to the first volume I presumed to narrate the circumstances under which I undertook the composition of my History. The great chemist and savant, whose inspiration has been my guiding principle throughout the arduous task and whose lengthy and appreciative review of the first instalment has been a stimulus in the continuation of it is no more. Marcellin Berthelot breathed his last on March 18, 1907, leaving the world of science poor indeed. It was with the view of coming into personal contact with the illustrious scientist that the author made a pilgrimage to Paris in March, 1905. The long interview which he had with M. Berthelot and the reception which was accorded to him at a meeting of the Academy of Sciences by its late Perpetual Secretary, as also by its President M. Troost, made a deep and lasting impression on his mind.

Alas, for the vanity of human wishes ! These pages will no longer be greeted by the eager and indulgent eyes of M. Berthelot. All that now remains for me is to dedicate this volume to his sacred memory.

It is with mingled feelings that I mark the hour of my final deliverance from a self-imposed task which has occupied all my spare time during the last 15 years and more—feelings not unlike those which overpowered the Historian of the Roman Empire. The reader will, I hope, forgive me if I venture to give expression to them in the words of Edmund Gibbon himself. “I will not dissemble the first emotions of joy on the recovery of my freedom. * * * * But my pride was soon humbled, and a sober melancholy was spread over my mind, by the idea that I had taken an everlasting leave of an old and agreeable companion.”

The Hindu nation with its glorious past and vast latent potentialities may yet look forward to a still more glorious future, and, if the perusal of these pages will have the effect of stimulating my countrymen to strive for regaining their old position in the intellectual hierarchy of nations, I shall not have laboured in vain.

PRESIDENCY COLLEGE

P. C. RAY

June 1, 1909.

PRELIMINARY REMARKS ON THE MECHANICAL, PHYSICAL AND CHEMICAL THEORIES OF THE ANCIENT HINDUS.

My paper on the *Mechanical, Physical and Chemical Theories of the Ancient Hindus* is intended to be a synoptic view of the entire field of Hindu Physico-chemical Science, so far as this reached the stage of positive Science as distinguished from the prior mythological and empirical stages. As the work in which my paper appears relates to Hindu Chemistry, I have elaborated the chemical portions, including the Hindu account of the constitution of the fats and oils and the organic tissues in addition to Hindu inorganic chemistry. I have also briefly noticed the chief chemical industries of the Hindus which secured them an easy pre-eminence in manufactures for a thousand years, and, in the *Addenda*, given some interesting recipes relating to several matters of chemical technology. Of mechanico-physical theories, I have expounded the Hindu conception of Energy, potential as well as kinetic, and of molecular motion, so far as they are applied to the elucidation of problems of a physico-chemical nature, *viz.*, the constitution of

matter, the genesis of atoms and their infra-atomic constituents, and the chain of mechanical causation in the system of Nature.. I have also touched on the Hindu theories of light, heat and sound, as implying current or wave motion, leaving the elaborate exposition to my paper on Hindu Mechanics and Physics. In the *Appendix*, I have added a brief account of the Scientific Method of the Hindus, which shows that all this was not a mass of unverified and unverifiable speculation (the very antipodes of science).—the charge usually brought against Hindu thought and culture,—but professed to be the outcome of a Scientific Methodology which, in its formulation of the canons of the two fundamental Inductive Methods, is more comprehensive as well as more original and suggestive than Mill, and which, as regards its Applied Logic of the Sciences, (*e.g.* the Logic of Therapeutics, of Grammar *etc.*), is a standing testimony to the systematic completeness and rigour of the Hindu scientific mind. The difficulties of my task have been formidable, but I have not written one line which is not supported by the clearest and most authoritative texts. The ground trodden is, for the most part, absolutely new. I have gone back to the *origines*, and studied the authorities at first hand, being resolved to eschew all second-hand sources of information. Fortunately the Sanskrit philosophico scientific terminology,

however difficult from its technical character, is exceedingly precise, consistent and expressive. The materials also are full and the sources of information corroborate one another. Another difficulty I have sought to guard myself against is the unscientific, unhistorical but very common and almost inevitable habit of reading modern ideas into old guesses or speculations of a happy-go-lucky or nebulous character. I do not think that the mere passion for Truth is a sufficient safeguard against this fatal facility of unconscious distortion or misrepresentation. A true historical perspective can only be acquired by historico-comparative studies, with the application of the correct historico-comparative method (*vide* the Introduction to my Comparative Studies in Vaishnavism and Christianity). I have also practised, or tried to practise, a habitual understatement, without consciously falling into that '*suppressio veri*' which is so often a '*suggestio falsi*'. How far I have succeeded in exhibiting the truth about Hindu science or the Hindu scientific mind is a question which I leave to competent judges to answer.

Before concluding, I must advert to my use of the terms "isomeric" and "polymeric" in senses different from the current ones, though suggested by the principle of analogous extension. Instead of coining new terms, I adopted (perhaps with a questionable freedom) these existing ones to ex-

press the Hindu idea of distinctions of chemical substances due merely to difference in spatial position or arrangement among the particles, without any implications whatever as to percentage composition or molecular weight. A study of the original sources has made it clear to me that a "Bhúta" in Hindu Chemistry represents a class of elements composed of similar atoms, and the different elementary substances comprised under one and the same "Bhúta" are 'isomers', in this limited sense, in reference to the atoms, being specifically constituted by differences of spatial position and arrangement among the latter. This is true of the Sánkhyá-Pátanjala and the Nyáya-Vaisesika alike. But in the Sánkhyá-Pátanjala, the atoms themselves are composed of Tanmátras; and in one view, the atoms that enter into the "isomeric" modes of the same "Bhúta" are themselves "stereo-isomers" in reference to the Tanmátras. A tri-Tanmátric atom, for example may have different isomeric forms which would account for the divers modes of the "Bhúta" originating with this class of atoms. Hence under the Sánkhyá Pátanjala, I speak of "isomeric" atoms, while under the Nyáya-Vaisesika I confine myself to the phrase "isomeric modes of the same Bhúta". It appears to me also that in the Sánkhyá-Pátanjala view, while an atom of a particular kind (say a tri-Tanmátric or a tetra-Tanmátric one) may have "isomeric" forms of its own, the

PREFACE

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atoms of the different “Bbúta” classes (from the mono-Tañmátric to the penta-Tañmátric) are what may in a broad sense be termed polymers of the A'kása Tanmátra and Bhútádi (matter-rudiment). Under the Sáñkhya-Pátanjala, therefore, I have spoken of “polymeric” atoms and “polymeric” combinations of these, though I must confess that I have done so with great diffidence and hesitation.

VICTORIA COLLEGE,
COOCH BEHAR.
23rd May. 1909.

B. N. SEAL.

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To the Memory of

M. P. E. BERTHELOT

I dedicate this volume of the History
of Hindu Chemistry.

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Introduction

CHAPTER I

On the age of Nagarjuna and the Buddhist Alchemical Tantras.

In the first Volume it has been incidentally mentioned that side by side with the Sivaite Tantras we have their Buddhist counterparts in which the salient features of the former appear.* The question now arises : when did the votaries of the religion of Sákyamuni find themselves called upon to engraft upon their simple and pure creed the *ensemble* of the gross and grotesque superstitions, the hideous incantations, as also the speculative, the metaphysical and esoteric phases of spiritual aspirations of which the Tantras are the repositories ? The answer cannot be given off-hand

Rise, development
and propagation of
Maháyánism.

* Vol. i, Intro. lxx.

in a few words, for it will lead us to a discussion of the origin and development of Maháyánism. Under ordinary circumstances we should have considered it beside our purpose to devote much space to this subject in a work dealing with the history of chemistry. But it so happens that the most prominent figure in Indian alchemy, who is acknowledged on all hands to be the discoverer of the processes of distillation, sublimation etc., is no other than the reputed founder of the Mádhyamika system of philosophy, the renowned Nágárjuna. A brief and rapid survey of the causes which led to the origin of Maháyánism and its intimate connection with the tenets of the Sivaite cult will be of help to us.

It is one of the saddest episodes in the history of the great religions of the world that the purity of life, right conduct, right living —in short, the moral code upon which their founders have always laid particular stress, soon begin to occupy a subordinate position and a dogmatic theology springs up in time, which gives occupation to the subtlest intellect.

As for the masses of the people it is doubtful if ever they have remained contented with the mere ethical aspect of a religion. At any rate we find that immediately after the tidings of the death of Buddha had spread about there was a squabble among his followers for the possession of the master's corporeal relics and in course of time stūpas were raised over them, which no less than the three jewels (*Ratnatraya*)—the Buddha, the Dharma and the Samgha,—and the Bodhi-tree became objects of worship of the devotee. The Chaityas, Vihāras and other sanctuaries of divers sorts, with which Buddhistic India was dotted over in the first and second centuries after the decease of the great teacher, afforded asylums for a vast multitude of monks, who, freed from all worldly cares, found ample leisure to formulate and draw up a code of spiritual and disciplinary exercises.

Although their high ideal was "to lead sweet lives of purest chastity" and induce their lay brethren to follow in their footsteps, rituals and ceremonials of an imposing and

elaborate character soon obscured the ray of light which shone forth from the founder. Thus we find that within 150 years after the passing away of Buddha tedious and circumstantial regulations as to the quality of robes to be worn by the Bhikshus, the mode of bathing and fasting, the taking of the midday meal, the drinking of unchurned milk, probation and penance, dwellings and furniture and so forth were amongst the weighty subjects for discussion in the Second General Council.* We need not pursue the subject further. The reader who is interested in the study of comparative religions will find striking parallels in the early history of the Christian Church.†

* "On the daily Life of the Bhikshus". Vinaya Texts (S. B. E. Series). The Chullavagga, Pt. iii, p. 66.

† The Sermon on the Mount was more or less forgotten. Idolatry disappeared, it is true, but only to re-appear in the shape of Mariolatry and the worship of Saints and relics. In the heat of the schismatic strifes, Christian Charity had to make shift for itself as best as it could. Theologians were busy with the interpretation of the writings of the fathers. In a word, the dogmatic to a large extent superseded the moral element of religion.

We are not concerned here with tracing the rise, progress or decline of Buddhism ; if we have at all referred to its excrescences, it is only to prepare the mind of the reader for the proper understanding of the Maháyánist development.

The India of Asoka and of the fourth and third centuries B. C. was in the main Buddhist, but it should not for a moment be supposed that the old faith was extinct. The triumph and ascendancy of the teachings of Sákyamuni and his followers were due in a large measure to the fact that they drew upon, and incorporated into, their creed much that was essentially of Hindu origin.* As Dr. Bhándárkar observes :—

* Prof. Rhys Davids expresses the same views in several places.—“There is ample evidence even in the books of the orthodox body of Brahman teachers to show that when Buddhism arose there was not only much discussion of the ultimate problems of life, and a keen interest in the result but also that there was a quite unusually open field for all sorts of speculations”.—“Buddhism.” American Lectures on the History of Religions (1893), p. 26. Again: “But Buddhism is essentially an Indian system. The Buddha himself was,

"But it was not the metaphysical doctrines of Buddhism that influenced the masses of the people. What proved attractive was its ethical side. The Buddhist preachers discoursed on Dharma or righteousness to the people. Such discourses on Dharma without the introduction of any theistic idea have their representatives in the Brahmanic literature. In many of the episodes of the Mahábhárata especially in the Sánti and Anusásanika books we have

throughout his career, a characteristic Indian..... he was the greatest and wisest and best of Hindus."—*ibid.* p. 117. The same high authority puts it more tersely when he says: "This is partly, no doubt, because we call them Buddhists, and imagine them, therefore, to belong to a separate class, quite distinct from other Indians of that stock. The Buddhists were, as a matter of fact, characteristically and distinctly Indian."—"Buddhist India," p. 165. Cf. "Buddhism, in fact, may be regarded as a reformed phase of Hindu religion and ethical activity. The Buddhistic doctrine of the vanity of the world had been thoroughly disseminated by Yájñavalkya (in the Satapatha Bráhmaṇa) and with it the practice of subsistence upon alms as Pravrájaka or Bhikshu ; and a fruitful soil had thereby been prepared for Buddhism". Weber's "Hist. Sans. Lit." trans. 3rd Ed. (1892) p. 285. Again "This teaching contains, in itself, absolutely nothing new ; on the contrary, it is essentially identical with the corresponding Brahminical doctrine ; only the fashion in which Buddha proclaimed and disseminated it was something altogether novel and unwonted."—*ibid.* p. 289.

simply ethical discourses without any reference to 'God, of the nature of those we find in the Buddhistic works'; and sometimes the verses in the Mahá-bhárata are the same as those occurring in the latter. There appears to be at one time a period in which the thoughts of the Hindus were directed to the delineation of the right conduct in itself without any theistic learning. And Buddhism on its ethical scale represents that phase. Right conduct is the last of the four noble truths of Buddhism."

* * * * *

"It was this phase of Buddhism that with the strenuous efforts of the missionaries and of the Emperor Asoka enables it to achieve success amongst the masses of the people; and what was wanting on the theistic side was supplied by the perfection and marvellous powers attributed to the founder of the religion. Without this faith in the perfection or, what we should call the divine nature of Buddha, a mere ethical religion would probably not have succeeded. Buddhism was not a social revolution as has been thought by some writers. It was a religion established and propagated by persons who had renounced the world and professed not to care for it. From times of old there existed in the Indian community such persons who were

called *Sramanas* and belonged originally to all castes. These gave themselves to contemplation and sometimes propounded doctrines of salvation not in harmony with the prevalent creed. Buddhism was not even a revolt against caste, for though men from all castes were admitted to the monastic order, and though in the discourses of Buddha himself and others the distinction of caste is pronounced to be entirely worthless, still the object of those who elaborated the system was not to level caste distinctions. They even left the domestic ceremonies of their followers to be performed according to the Vedic ritual. This is one of the arguments brought against Buddhism by Udayanáchárya. "There does not exist", he says, "a sect, the followers of which does not perform the Vedic rites beginning with Garbhádhána and ending with the funeral, even though they regard them as having relative or tentative truth"*. Buddhism, however, was a revolt against the sacrificial system and denied the authority of the Vedas as calculated to point out the path to salvation. And

* नास्येव तद्दर्शनं यत्र साङ्केतिदिव्युक्तापि गर्भाधानाद्यन्वेष्टिपर्यन्तं
वेदिकोऽक्षया अनी नामुतिष्ठति। Atmatattvaviveka, Calc. Ed. of
Samvat 1906, p. 19. साङ्केत relating to संकेत a Buddhist technical term.

this is the root of the hostility between itself and Brahmanism."*

The zealous missionaries of Buddhism captured the heart of the masses by appealing to their moral instincts. Persuasion and not persecution was the instrument they chose to wield. King Asoka proclaimed universal toleration ; he inculcated respect for Brahmins as well as *Sramanas* or ascetics of all sects. It is a relief to find that the mighty monarch had never recourse to brute force for the propagation of his creed. We are spared all the scenes of blood, rapine and violence, which disfigure the pages of religious history in the West.

It has already been pointed out that Buddhism itself may be looked upon as an offspring of Hinduism ; nay, it is a logical outcome of the principles enunciated in the

* "A peep into the Early History of India from the foundation of the Maurya Dynasty to the fall of the Imperial Gupta Dynasty" (B.C. 322—Circa 500 A. D.) pp. 362-363.

Journal of the Bombay branch of the Royal Asiatic Society (1900), Vol. xx. No. LVI.

Sámkhya system of philosophy. If India so readily responded to the teachings of the new faith, it is not because she renounced Hinduism but because she found that all that was highest and noblest in the latter was absorbed in the former. The great Teacher who now arose gave only a new shape and direction and a vigorous impetus to the germ of ideas already in existence and turned them to capital account. A good deal of confusion may be avoided by bearing in mind this aspect of the question. When speaking of Buddhist India one is apt to rush to the conclusion that every vestige of Hinduism had disappeared off the face of the vast continent. As a matter of fact even during the zenith of Buddhistic glory Brahminism was rearing its head and was professed by not a few among the culture and intellectual classes and was ready to assert itself whenever a favourable occasion arose.

In the second century B. C., we find the Kabul valley, the Punjab and Málava ac-

knowledging the sway of the Princes of the Turkish race.* Wema Kadiphses, the second of the Kushana Dynasty is spoken of as a devotee of Mahesvara ; his coins bear the emblem of Nandin on the reverse, which is accompanied by a human figure which holds a trident in its right arm representing Siva. † The last three Kushanas—Kanishka, Huvishka and Vásudeva—have been noticed in the Rájatarangini,‡ and the emblems on the reverse of their coins are figures of deities borrowed from the Greek, Persian and Brahminical pantheon and of Buddha. Thus the Gods of all these four religions shared the adoration of these Turkish Kings. But the figure of Buddha in the

* Lassen "Indische Alterthumskunde," Vol. ii, pp. 811-13 Ed. 1874.

† *Ibid*, pp. 808-811.

‡ See next page. Regarding the reliability of the account in the Rájatarangini, Dr. Stein observes :—"Kalhana's account of the reign of these kings, who are supposed to have ruled simultaneously, is brief enough, but undoubtedly preserves data of genuine historical tradition. It clearly describes them as princes of Turuska, i. e., Turkish nationality, as powerful sovereigns and as faithful patrons of the Buddhist Church. On these points the statements of

sitting or meditative and the standing posture is to be found on the coins of Kanishka alone.*

In the Buddhist ecclesiastical history Kanishka occupies a prominent place. It was in his reign and under his patronage that the Third Council was held to settle the canon once again. The church was convulsed by internal dissensions and schisms, resulting in its being split up into as many as 18 sects. "The most significant trait of the Third Council is that it closed a period of old quarrels between the sects ; it did not prevent the rise of new aspirations. Maháyánism, which in an incipient stage was already existing ere long, boldly raised its head."†

the Chronicle are fully supported by the evidence of our most authentic records. The continued existence of the three places, Kanishkapura, Hushkapura, and Jushkapura, which are described as foundations of these kings and which still survive to the present day is likely to have assisted in preserving a recollection of their founders."

* Percy Gardner : "Coins of Greek and Scythic kings" pp. 129 ff.

Cunningham : "Num. Chr." 1892, pp. 63 ff.

† Kern : Manual of Ind. Bud. (Grundiss d. Indo-Arischen Phil.) p. 122.

Hinduism was now very much alive. After the Third Council the distinction between the Hínyániṣts and the Maháyániṣts became more and more accentuated. The apostles of the latter development became convinced that in order to draw into their folds the bulk of the people some sort of compromise was necessary, that orthodox Buddhism in all its rigidity must be given up. In other words, the neo-Buddhism which now sprang into existence began to absorb and assimilate the popular form of Brahminism and thus swell the ranks of its followers. A purely ethical creed has never secured a following except perhaps among a chosen few. To quote the eloquent words of the historian of "Rationalism in Europe" :—

"There arise from time to time men who bear to the moral condition of their age much the same relations as men of genius bear to its intellectual condition. They anticipate the moral standard of a later age, cast abroad conceptions of disinterested virtue, of philanthropy, or of self-denial that seem to bear no relation to the spirit of their time, inculcate duties and suggest motives of action that

appear to most men altogether chimerical. Yet the magnetism of their perfection tells powerfully upon their contemporaries. An enthusiasm is kindled, a group of adherents is formed, and many are emancipated from the moral condition of their age. Yet the full effects of such a movement are but transient. The first enthusiasm dies away, surrounding circumstances resume their ascendancy, the pure faith is materialised, encrusted with conceptions that are alien to its nature, dislocated, and distorted till its first features have almost disappeared. The moral teaching being unsuited to the time becomes inoperative until its appropriate civilisation has dawned, or at most it faintly and imperfectly filters through an accumulation of dogmas, and thus accelerates in some measure the arrival of the condition it requires." Vol. i, p. 305, Ed 1900.

The same historian in explaining the rapid spread of Christianity in Europe, observes in another place :—“It triumphed not so much by superseding rival faiths as by absorbing and transforming them. Old systems, old rites, old images were grafted into the new belief, retaining much of their ancient character, but assuming new names and a new complexion.”

Among the bold spirits who took a leading part in this renovation the name of Nágárjuna stands conspicuous. The Mádhyamika system, with its axiom—*sarvam Sunyam*—a form of Pyrrhonism pushed to its extreme limits,

Nágárjuna : a leading representative of Maháyánism.

which is an essential part of Maháyánism, is generally ascribed to him. Northern Buddhist literature is replete with the marvels and miracles performed by him, and tradition has invested him with superhuman powers, Hiouen 'Thsang calls him along with Deva, Asvaghosha and Kumáralabdha, "as the four suns which illumine the world."* As early as A.D. 401-409 we find a life of Nágárjuna Bodhisattva translated into Chinese.† Tára-nátha has committed to writing all the floating mass of legends connected with this venerable name, but as the Tibetan monk wrote so late as the beginning of the 17th century A.D., and as nothing was too astounding for his pious credulity, we have here only

* Julien's texts, Vol. ii, p. 214.

† Bun. Namjo's Catalogue, Ap. i, No. 3.

nuclei of facts round which have gathered accretions of vast proportions. It is now almost a hopeless task to separate the grain from the chaff. Nevertheless we can glean certain historical data from all that have been handed down. Before proceeding further we think it proper to treat the reader to a specimen of the materials with which one has to deal. We cull the following bits from the "Life and Legends of Nágárjuna" gathered chiefly from Tibetan records including Táranátha's "History of Buddhism."

"A rich Brahmin of the Vidarbha country to whom no son had been born for many years, once saw in a vision, that if he gave alms to, and entertained one hundred Brahmins, he could get a son. Accordingly he made offerings and prayers to the God and entertained one hundred Brahmins. After ten months his wife gave birth to a son. The rich man invited learned astrologers to predict the fortunes of his child ; but they found that it could not live more than a week. In all other respects the child was calculated to be fortunate..... The astrologers assured them (his parents) that if they entertained one hundred Bhikshus, it would

live seven years, beyond which its life could not be prolonged by any means whatever. When the seventh year was about to expire the parents were overwhelmed with grief. To avoid the painful sight of their son's predicted death, they caused him to be removed to a certain solitary place in company with a few retainers.

"As the boy (Nāgārjuna) was passing his mournful days, one day the Mahābodhisattva Avalokiteśwara Khasarpana visited him in disguise and advised him to go to the great monastery of Nālendra in Magadha as the surest means of escaping from the hands of death. He accordingly repaired to that famous Vihāra and arriving at the gate recited some gāthās. During that time the great sage Sri Saraha Bhadra was the high priest of Nālendra, who ordained Nāgārjuna a Bhikshu of the Vihāra. * * * * During the latter part of his office the country was visited by a famine in consequence of which the monks fell into great distress. The Manager became very thoughtful about the terrible effects of the natural calamity. Distress and scarcity compelled the congregation more keenly to feel the necessity of money. The monks now determined to devise some means of acquiring treasures for the support.

of the famished congregation, and Nāgārjuna accordingly started on an expedition to visit an island in the great ocean where lived a great saint well versed in the art of alchemy. As the sea could not be crossed by any earthly means, he, by dint of his divine learning, got two leaves of an enchanted tree, by means of which he crossed the ocean and miraculously visited the island and presented himself before the sage who was greatly surprised to see a human being arrived at his abode deemed inaccessible to mortal beings. The sage earnestly inquired how he succeeded in achieving this wonder. Nāgārjuna replied respectfully stating to him the reasons of his visit and circumstances that brought him thither. He also showed him one of the enchanted leaves, concealing the other in his mendicant's platter. He begged him to teach him the art of turning metals into gold. The sage consented to the proposal, but not liking to let the wonderful art be known in Jambudvīpa, he determined to detain him for ever in the island by depriving him of the enchanted leaf. To effect this, he said that he could not teach the art of alchemy unless Nāgārjuna consented to part with the leaf. Nāgārjuna consented, and was taught the art. When it was fully mastered, he flew towards the Indian Continent by the help

of the remaining leaf. Returning to Nālendra, by means of his easily acquired wealth he supported the whole body of monks. By his religious practices he obtained Siddhi (perfection). He refuted the theories of Samkarāchārya* and imparted religious instruction to the monks of Nālendra.

“Nāgārjuna returned to his country after a visit to Uttarakuru and erected many chaityas and temples, composed many works on science, medicine, astronomy and alchemy. After the death of Saraha Bhadra, the office of high priest fell upon Nāgārjuna, which he managed with great ability and indefatigable zeal. He matured the Mādhyamika philosophy which was only conceived by his illustrious teacher Saraha.”

“Nāgārjuna is said to have been a great friend of king De-Chye (*Samkara*) of S. India, whom he converted to Buddhism.”

* An instance of glaring anachronism. *Samkara* flourished in the 8th.—9th century A. D. See below, foot-note to p. xxii.

+ S. C. Dás : Journ, As. Soc. li, Pt. i, pp. 115—120.

One thing seems to be clear from the above, namely, that Nágárjuna was born and brought up in the Brahminical faith but was afterwards converted to Buddhism and was celebrated as an alchemist.

Táranátha, it is true, completed his History in 1608 A. D., * but he derived his materials from Tibetan sources and the analysis of Dulva by Csoma goes to confirm this account. We have already made use of the record left us by Hiouen 'Thsang. † It is thus clear that all the testimonies concur in ascertaining Nágárjuna not only as the originator of the MÁdhyamika philosophy but also as an

Nágárjuna as an
adept in magic
and alchemy.

adept in magic, conjuration and alchemy, and that even so early as the 7th century

A. D. The exact time during which he flourished is a matter of controversy. He is generally regarded as a contemporary of

* Schiefner : Gesch. d. Bud. Pref. vi.

† Véz Vol. i, Intro. xciii.

Kanishka. One cannot go far wrong in assigning *circa* 150 A. D. as the date of his succeeding to the Patriarchate.*

* According to Lassen Nágárjuna lived about A. D. 23 during the reign of Kanishka. The Rájataramgini says : "Then there were in this land three kings called Hushka, Jushka and Kanishka, who built three towns named after them (Hushkapura, Jushkapura and Kanishkapura)..... During the powerful reign of these [kings] the land of Kásmir was to a great extent, in the possession of the Buddhas. At that time 150 years had passed in this terrestrial world since the blessed Sákya Simha (Buddha) had obtained complete beatitude (Nirvána)..... And a Bodhisattva lived (then) in this country as the lord of the land, namely, the glorious Nágárjuna..... Stein's trans. Vol. I. pp. 30—31. As the tradition of the Northern Buddhists as recorded by Hiouen 'Thaang (Si-yu-ki, 1. pp. 99, 151, the Tibetan Dulva (Csoma, As. Res. XX, pp. 92, 297) as also Schieffner (Tar, Gesch. d. Bud. p. 301) concur in placing the commencement of Kanishka's rule 400 years after Buddha's Nirvána, the date assigned here to Nágárjuna is rather curious. Lassen sums up his conclusion on this knotty point in these words :—"Wegen der grossen Anzahl seiner Munzen mus dem Kanishka eine ziemlich lange Regierung Zugeschrieben werden ; ich glaube daher annehmen zu dürfen, das er etwa bis 40 nach Chr. G. regiert habe." Fleet maintains B. C. 57. V. Smith c. 120 A. D. While Messrs. Bhándárkar c. 278 A. D. (Journ, Bombay Br. Roy. As. Soc. Vol. XX, No. lvi, pp. 269—365) as the date of Kanishka.

An important document has been preserved for us in its Tibetan and Chinese versions, which seems to have an historical basis. It is in the shape of a "Friendly Epistle of Nágárjuna to king Udyana."*

Nágárjuna as a contemporary and friend of king Sadváhana.

The original in Sanskrit, entitled *Suhrillekha*, has not yet been recovered and probably

been lost. Udyana in the Tibetan subscription is Bdye-Spyod = Sadváhana.† This Sadváhana is a prominent figure in the history of S. India. In ancient Sanskrit literature he is frequently spoken of as a patron of learning and there are several literary reminiscences associated with this name.‡

* *Vide Wenzel* : Journ, Pali Text Soc. (1886), p. 1.

† S. C. Dás (l. c.)'says : "Nágárjuna is said to have been a great friend of king De-Chye (i. e. Samkara) of S. India whom he converted to Buddhism." Now De-Chye= Bdye-byed according to modern pronunciation. Dás is evidently in error in rendering De-Chye as Samkara (Wenzel).

‡ Cf.—Kàmasútra of Vâtsyàyana. कामसूत्रं कुम्भः आतकिं
आतवाहनी महादेवे मलवर्णो [अष्टान] ; Referring to a "new"
MS. of *Harshacharita* in his possession Hall remarks—"for
Sáliváhana I there find Sàtaváhana"—Intro. to "Vâsavadattä."
p. 54. This by implication would suggest that the other
MS. had the reading Sáliváhana.

Now “the Andhrabhrityas or *Sátaváhanas* ruled over the Deccan from B. C. 73 to about A. D. 218, i.e., for about 3 centuries.

“The period during which they ruled over **Maháráshtra** must have been a prosperous one in the history of the country. Hence several traditions with regard to different kings have been preserved.. But that *Sáliváhana* or *Sátaváhana* was a family name must have been forgotten and different princes of the dynasty have been confounded and identified. Thus Hemachandra in his Desikosha gives *Sáliváhana*, *Sálana*, *Hála* and *Kuntala* as the names of one individual.” *

The So-to-p'o-ho of the Chinese version of the “Friendly Epistle” has been identified with one of the *Sátaváhanas* or Andhra kings, possibly *Yajna-Srí-Sátakarni*. who seems to have reigned about 172—202 A. D. There is, therefore, nothing improbable in this particular, *Sátaváhana* being a contemporary of *Nágárjuna*. In the alchemical Tantra, “*Rasaratnákara*,” ascribed to *Nágárjuna*,

* Bhāskarā's “Early History of the Deccan”—p. 36.

there is a ~~o~~ ^{real} difference between this sage and Sáliváhana (p. 11). We shall revert to this subject later on.

Numerous works have been ascribed to Nágárjuna and it is an open question if any of them be genuine.* As is well known Vyása or more properly named Ve-davyása has been taken to be the compiler of not only the four Vedas but also of all the Puráṇas put together. Piety and credulity go hand in hand and are seldom troubled with questions of anachronism. Plato, Democritus and Geber have been held responsible for writings which ap-

Nágárjuna as a comprehensive name of the activity of Maháyá-nism. peared several centuries later. Names, venerable and illustrious, have often been pressed into service to lend weight and dignity to productions which otherwise would not have commanded a respectful hearing. "On the whole we are inclined to agree

* In Bunyin Nanjio's Catalogue of the Bud. Tripitaka there is a list of 24 works ascribed to Nágárjuna. The *Suhṛleśkha* was translated into Chinese in 434 A. D. App. pt. I, p. 368.

with Kern when he says, "The figure of Nágárjuna, so prominent in the history of the rise of Maháyánism, shows a double character. It is, on the one side, the name of an influential person, the first eminent leader of a school imbued with Hinduism and the methods of Indian scholastic philosophy. • On the other hand, Nágárjuna is simply a comprehensive name of the activity of Maháyánism in the first phase of its onward course."*

* In Vol. I of this work (Intro. xciii), we quoted Albérûni as to the date of Nágárjuna. This cultured Arab, ordinarily a very trustworthy guide, derived his information from the Brahmins of that part of India from which every vestige of Buddhism had disappeared in the 11th century and he was evidently misled on this point as the traditions relating to Nágárjuna had at that distance of time become very vague. This will be clearly seen from what Prof. Sachau says in the preface to the Arabic edition of Albérûni.

"Its civilization was then essentially Brahminical as it had come to be in a protracted struggle with Buddhism. Albérûni does not know Indian Buddhism from personal experience though it had not yet entirely withdrawn from India and in some part was still a political power. (p. v.)

"The valley of the Kábûl river and the Punjab are all that Albérûni has seen of India. (p. xiii.)

"The high schools of Hindu science and learning, Kasmir and Benares, were in Albérûni's time unapproachable for Muslems. (p. xiv.)"

From the time of Nágárjuna onwards Ma-háyánism began to be tinged more and more with Brahminical bias. A notable and decided step in this direction was taken by Asamga, a monk of Gándhára, who composed the Yogáchára-bhúmisrastra, in which by assimilating the doctrines of Patañjali he paved the way for the growth of Tantras. He seems to have lived about 400 A. D.* Vasubandhu, Asamga's younger brother, was another ze-

* Cf.—Takakusu : Journ. Roy. As. Soc. Jan. 1905.

A life of Vasubandhu was translated into Chinese by Paramārtha. A. D. 557-569.—Bun. Nanj. Cata. p. 371. Csoma Korosi following the Tibetan Chronology says :—"I know that Arya Asamga lived in the sixth or seventh century after Jesus Christ." As. Res. XX, p. 513. This date has been accepted by Lassen (*Ind. Alt.* ii, p. 460) as also by R. Davids (*Buddhism.* p. 207). But this chronology has now become untenable. The date of Asamga and his brother Vasubandhu should be put back by about two centuries, as some of their works were translated into Chinese in the beginning of the fifth century and perhaps earlier. (Bun. Nanj. Cata. App. i p. 371). It must have taken a century or two to have their works sufficiently recognised in India before they would deserve a place in the Chinese Tripitaka.

lous adherent of this school and is said to have been a teacher in the college attached to the monastery of Nálentra—the “Oxford of Indian Buddhism.” From Tibetan sources we learn that the celebrated logician Dignága was a disciple of Vasubandhu, a contemporary of Lha-tho-ri, king of Tibet, who lived up to 371 A. D.*

Gradual and imperceptible fusion of Maháyánism with Saivaism.

Maháyánism now began to adapt itself to its environments. The absorption of the Yoga ideas made the transition into the Tantric cult easy and Northern Buddhism began to develop and expand by entering into an alliance with Saivism, which favoured the growth of Buddhist Tantras. The origin and development of this class of literature have been the subject of a masterly exposition by Burnouf. The Maháyánists not only set up their own deities but borrowed copiously from the pantheon of the Hindus. Thus in the Sivaite Tantras while

* S. C. Vidyábhúshana : Journ. As. Soc., Vol i, (1905), p. 227.

the God *Siva* is the fountain of all knowledge and sciences, in their Buddhist counterparts we have the celestial, metaphysical and potential Buddhas* occupying the same position. The worship of the female energies (*Sakti*) which plays such an important part in the Tantras was encouraged in the person of Tárá. The Hindu Gods and Goddesses were also objects of adoration, only they were assigned a subordinate position. The question has often been asked : why did Buddhism seek alliance with Saivism in preference to the Vishnuvite cult ? The answer seems to lie in the fact that it was precisely in those parts of India where the worship of *Siva*, especially in its Tántric form, had struck root that Maháyáñism asserted its sway ; † and thus the apostles and propagators of the latter made most of the former. A few centuries later when Vaishnavism gained an ascendancy in Bengal the tables seem to have been turned. A gradual and imperceptible fusion

* i. e. the Bodhisattvas.

† Vide ante. p. xi, (under *Wema kadiphee*).

took place between the rival creeds. Thus in the celebrated adoration in the opening lines of Gítagovinda we find Buddha freely acknowledged as an incarnation of Vishnu and extolled for his abhorrence of sacrificial rites.*

From Fah-hian's travels we gather that in the beginning of the 5th century A. D., the Maháyánists were gaining the upper hand, though their rivals, the Hináyánists, were still holding their own in several localities. Thus at Mathurá and Pátaliputra he found the members of both the sects living side by side and having monasteries of their own.

* निर्वासु यज्ञविदेरहह श्रुतिजातम् सदयहदयद्विंतपयुक्तातम् । केषम्
भृतयुक्तवरीर अय अनदीष्म हरे ॥

It is scarcely correct to assert that Buddhism was exterminated in the land of its birth by cruel persecution. Cf. Vol. i. Intro. lxvii. The Bengali poet Ramchandra Kavibharati, author of *Buddha Sataka*, though a devoted Buddha, belonged to the same class of thinkers as Jayadeva. Pandit S. P. Sástrí is inclined to place him in the latter end of the 13th century.—Journal of Buddhist Text Society, Vol. I. Pt. iii. So late as 1441 A. D. MSS. of Buddhist works used to be copied from in Magadha.—Bendall's Camb. Cata. of Bud. Sans. MSS. (1883), pref. iv.

From the fact, however, that the pious Chinese pilgrim repeats the Suramgama Sútra for his protection, we may conclude, since he is by no means a pronounced Maháyánist, that the predisposing causes for the origin of the Tantras were already in existence. "In this Sútra is contained the most complete list of Dháranís (invocations) found in any Chinese compilation. There are 426 distinct sections containing the names of the different Buddhas and Hindu deities worshipped at the time of the composition of the Sútra. Considering that Fah-hian in the early part of the 5th century regarded this book with reverence. We may reasonably assign it to a period not later than the end of the 1st century. Now amongst the invocations we find distinct reference to Dhyání Buddha, Vairochana, Akshobhya, Amitábha and others shewing that they were coming to be recognised and worshipped even at that early date." *

* Intro. to Beal's "Fah-hian." (Lxxii).

Dháranis as the precursors of the Tantras.

These Dháranis may be looked upon as the precursors of the Tantras and they fully support the views that when they were composed Buddhism had turned a new leaf. The repeating of certain magic formulas along with the names of Buddha Amitábha, etc., was to secure salvation, in other words, "instead of the old doctrine [of *Karman*]—as a man soweth, so he shall reap—a new and easier way of salvation is here preached, *viz.*.. as a man prayeth, so he shall be saved. It is what is known to us as salvation by faith rather than by works. It would almost seem as if this popular and easy doctrine had secured to itself the name of Maháyána, as meaning the Broad Way, in opposition to the Narrow Way, the Hína-yána.*

The new class of literature which now arose in order to meet the demands of the Maháyánist revival is collectively known as

* Max Müller, Buddhist Maháyána Sútras. Intro. to larger *Sukhávatí-Vyūha*, i x. S. B. E. Series, Vol. xlix.

the Vaipulya Sútras or the Sútras of the Vaipulya Sutras. developed school, of which the Dháranis are an integral part. It found expression in such works as the "Saddharma-pundaríka," "Lalitavistara," "Tathágata-guhyaka," "Prajñápáramitá," etc., —all of which soon acquired almost canonical sanctity in the estimation of the N. Buddhists. Burnouf has tried hard to differentiate between the simple Sútras as represented by the literature of the primitive orthodox Buddhism and the expanded Sútras of which the distinguishing mark is the occurrence of Bodhisattvas.* This drawing of hard and fast

* 'La présence des Bodhisattyas ou leur absence intéresse donc le fonds même des livres où on la remarque, et il est bien évident que ce seul point trace une ligne de démarcation profonde entre les Sútras ordinaires et les Sútras développés.—Burnouf, Intro. p. 112; *ibid.* p. 120. Ed. 1844. *Vide* Max Müller's remarks at the end of the Smaller *Sukhāvatī-Vyūha*, p. 102, S. B. E. Series, Vol. xlix.

Cf. also "Some Vaipulyas are, materially, much like the old Sútras, whole passages e.g. of Lalita-Vistara recur almost word for word in the Páli Scriptures." Kern (Ind. Bud. p. 5). This eminent Buddhist scholar also very appositely re-

lines has been found to be well-nigh untenable.*

By the second century A. D. we find the leading beliefs and ideas as crystallised in the Maháyána literature fully in vogue. Thus we

marks elsewhere : "The results arrived at by Burnouf may be right so far as Mahávaipulya Sútra as a whole is concerned, they cannot be applied to all the component parts of such a work. Not to go further than the Saddh. and the L. Vistara, it can hardly be questioned that these works contain parts of very different dates, and from various sources."—Kern, Intro. to Saddh., pp. x-xi. Passages in L. V. are literally identical with those in Mahávagga. Again :—"These few examples I have chosen will suffice to prove that the material of a Mahávaipulya Sútra is partly as old as that of any other sacred book of the Buddhists."—*Ibid.*, xiv.

* The truth seems to be that "the historical relation between the Hínayána and the Maháyána schools of Buddhism is to me as great a puzzle as ever."—Max Muller, Intro. to L. Sukh. Vyúha, ix. Even the very distinction between the N. and the S. Buddhism has been taken strong exception to by R. Davids, who says :—"There is not now and never has been, any unity either of opinion or of language in what is called northern, or in what is called southern Buddhism. There is a distinct disadvantage in continually suggesting a unity which has no existence in fact. In a word the current division of Buddhist literature into northern and southern is entirely unscientific, and misleading."—Bud. India, p. 173.

come across in the “Buddhacharita” of **Asvaghosha**, who is admitted on all hands to be a contemporary of Kanishka, such a passage as this : “this, Sirs, is the Mahá-yána, the instrument of the law of the perfect Buddha, which is the establisher of the welfare of all beings, set forth by all the Buddhas.”* The “Lotus of good Law” was translated into Chinese at the close of the second century A. D. †

Side by side with the growth of the scriptures another class of literature was called **Buddhistic Tantras.** into being by the exigencies of the times—we mean the Tantras, the necessity for which has been hinted at in the first volume. ‡ However esoteric may be the doctrines sought to be conveyed through the medium of these productions, it would be idle to deny that there

* Cowell's trans. p. 184. S. B. E. Series, Vol. xl ix.

† Edkin's “Chinese Buddhism,” p. 89. There were several versions of this sacred book.—*Vide* Kern's Intro. p. xxiii (S. B. E. Series).

‡ Vol. i. Intro. lxx.

is much in them which is calculated to pander to the baser instincts of frail humanity. At what particular time these Tantras appeared on the scene is yet a matter of conjecture, but the views of Wilson which held the ground for more than 30 years have now been found to be erroneous. Evidence is now forthcoming from quite an unexpected source, which goes to prove that Buddhist Tantras existed as early as the fifth or sixth century A. D., if not earlier. * If Buddhist Tantras, again, pre-suppose the existence of Hindu Tantras, one need not be considered as rash in assigning an earlier age to the latter. †

* *Vide* the palm-leaf MSS. discovered in the monastery of Horiuzi in Japan and carried from Central India. One of these is in the handwriting of a famous Chinese priest, named Kanshin, who came to Japan in A. D. 753. The MS. contains besides a Dháraṇí, five Tantras. "Bud. Texts from Japan," ed. by Max Müller. Vol. i, pt. i, Intro, pp. 6-8. It is fair to conclude that these Tantras existed in the land of their birth at least two centuries earlier.

† Waddel says :—"No one has yet realised the vast extent to which Maháyána and Tántric Buddhist remains cover India; nor sufficiently realised the leading part played by the Maháyána in Indian Buddhism during its popular period." Journal of the Roy. As. Soc. (1894).

The Tantras found a congenial home in China. Amoghavagra, a *Sramana* of northern India and a Brahmin by caste resided in the Celestial Empire for several years between 746 and 771 A. D., and under his influence the Tántric doctrines dealing with talismanic forms and professions of supernatural power first gained currency there.* Hence long before his time Tantras must have been popular in India. From the eighth to the eleventh century A. D. we are in possession of authentic records as regards the prevalence of Tantras in Northern

Tantras imported
into Tibet.

India ; as it was about this period that several of these were gradually imported into Tibet by Indian Pandits, but they must have been composed much earlier. †

* Bun. Nanjo's Cata. App. ii, p. 445. Amoghavagra translated 77 works including Ushnisha-chakravarti-tantra, Garudagarbhaga-tantra and Vagrakumára-tantra.

Cf.—Also "The existence of the Tantra Sástras may thus apparently be traced at least as far back as the 6th century A. D."—*Vide "Annual Report," As. Soc. Beng. 1906.*

† In the first half of the eighth century two eminent

Atisa gave a fresh impetus to Tantrism in the land of snow. From the analysis of Mdo by Csoma we also come to know in detail the names with the dates of the Indian scholars who with the aid of the local interpreters (*lochavas*) rendered into Tibetan the various Sanskrit Tantras. The faithful accuracy with which these translations were made and their fidelity to the original enable us often to reproduce the Sanskrit Texts and thus we are in possession of valuable histori-

Pandits of Bengal visited Tibet at the invitation of its king and formally introduced there Buddhism; these Pandits were Sánti Rakshita, high priest of the monastery of Nálená and his co-adjutor Padma Sambhava, a native of Udyana, who took charge of the Tántric part of the Buddhist liturgy. They were followed by the sage Dípamkara-Srí-jnána (Atisa), b. A. D. 980, d. 1053. He acquired proficiency in the three pitakas of the four classes of the Hínayána Srávakas, in the Vaiseshika philosophy, in the three pitakas of the Maháyána doctrine, the metaphysics of the Mádhyamika and the Yogáchárya schools and the four classes of the Tantras. At the request of king Naya Pála he accepted the post of high priest of the monastery of Vikramasila.—*Vide* S. C. Dás,—Journal of the Buddhist Text Soc. Pt. i.

cal data.* Some of these Tantras deal with alchemy and their contents reveal to us the knowledge of chemical processes in India from about the 6th to the 8th century A. D.†

Fortunately we are not dependent upon the Tibetan Tantras alone for gaining an insight into this dark recess in *Rasaratnákara*.[‡] the history of Hindu intellectual activity. In the course of our search

* Speaking of the Tibetan translation of Asvaghosha's *Buddha-Charita*, Cowell remarks : "The Tibetan version appears to be much closer to the original Sanskrit than the Chinese ; in fact from its verbal accuracy we can often reproduce the exact words of the original, since Sanskrit words are always represented by the same Tibetan equivalents, as for instance the prepositions prefixed to verbal roots."—I. c. Intro. p. x. Waddel is equally impressed with the "profoundly accurate and scholarly nature of the Lámaist translations of Sanskrit Buddhist books ;" and he again observes : "It is clear that the Tántric and Maháyána features of Lámaism were imported *en bloc* from Indian Buddhism."—Journal of the Royal As. Soc. for 1894, p. 15.

† Analysis of the contents of the Mdo (Sútra) by Csoma de Korosi—Asiatic Researches, XX (1836), p. 583. "A work on preparing quicksilver, the most powerful for subduing every sickness and for improving the vigor of the body."—"A work on turning base metals into gold." We are thus reminded of the contenta of the Rasáravá and the Rasaratnákara, Víde p. 2.

for MSS. of alchemical Tantras we have come upon a precious find, in the shape of a Buddhist Tantra, with Nágárjuna as its reputed author. Of alchemical Tantras we have had enough and to spare ; but there is great difficulty in assigning dates to them, as they one and all pretend to emanate from the mouth of the God Siva himself. We are only left to internal evidences—evidences based upon the gradual evolution of chemical processes, which we have not been slow to take advantage of. The MS. in question is a mere fragment, but it is calculated to

Its historical importance. evoke all the zeal and enthusiasm of a Palaeontologist—of an Owen or a Marsh—in his efforts to restore an animal and assign to it its proper place in the economy of the laws of evolution, when he luckily chances upon a fossil impression of its tooth or claws. From this point of view *Rasaratnákara*, for such is the name of our MS., is of uncommon interest. It is a Tantra of the Maháyánist school and as such its invocations are

addressed to all the Buddhas ;* and in one place there is a pointed reference to Prajñá-páramitá †(perfection of wisdom) appearing before Nágárjuna in a dream and revealing to him chemicel knowledge.‡

A noteworthy feature of this work is that some chemical processes are discussed in the form of a dialogue between Sálivákana and Nágárjuna, and Ratnaghosha and Mándavya.§ These last two names are held equally in veneration with Nágárjuna and grateful acknowledgments to their services occur in some later chemical treatises.¶ The bringing together of these four *dramatis personæ*.

* शिष्यव दर्शनुदान्। Cf. The opening invocation in the Sukhávatí Vyúha : शो वलः श्रीहर्षतुदवीषिस्त्वेभः। also वलः प्रवेक्षुष चार्यवापकाचान् वलो वेषिकस्त्वान् in A'rya Mañjuśrímúla Tantra.—Vide As. Res. xx, p. 512.

† Cf.—The invocation in Vagrachchhediká वलो अगवला चार्यवापकाचारमितादे.

‡ Vide Sans. Texts, p. 10, also Trans., p. 5.

§ Vide Sans. Texts, pp. 12-14, also Trans., pp. 6-8.

¶ Cf. Vol. i, p. 77.

especially of the first two has a significance of its own. We have already seen that references to Nágárjuna and his contemporary king Sáliváhana are only to be met with in ancient classical literature (*vide ante xxii*). It seems probable that Rasaratnákara was written at a time when the memory of these personages was still fragrant. Judging from internal evidences also we come to the conclusion that it is one of the earliest works extant on the subject. In our attempt at throwing light on the text of Rasárnavá, we had to quote several parallel passages from it,* and from a careful perusal of both we are

Also a typical
production of the
Maháyánist period.
of intellectual ac-
tivity.

of opinion that the latter is the inspirer rather than the borrower. Rasaratnákara, in short, seems to us to be a

typical production representing the Maháyánist period of intellectual activity and we may not be wide of the mark if we put down 7th or 8th century A. D. as its latest date.

* *Vide Vol. i, Sans. Texts, pp. 7, 12, 13 and 18.*

From the 5th to the 11th century A. D. the colleges in connection with the monasteries of Pátaliputra, Nálandá, Vikramasila, Udand-pura, etc., were the great seats of learning as the temples attached to the pyramids in ancient Egypt ; and alchemy was included in the curricula of studies.*

The existence of a vast ancient Tántric literature with alchemy as a component part has now been placed beyond doubt, thanks to the searching examination of the Mahárájá's collection of valuable MSS. of Nepal by the eminent scholars Bendall, H. P. Sastri and S. Lévi. Of surpassing interest is the discovery of a Tantra belonging to the extinct school Kub-jikámata, written in Gupta character and copied about the sixth century A. D. This

* Cf. "By the side of the tower of king Asoka is built a Samghávása, belonging to the great vehicle, very imposing and elegant. There is also a temple belonging to the little vehicle.....In the college attached to the temple one may see eminent Sramanas from every quarter of the globe."—Beal's "Fah-hian," ed. 1869, p. 105.

school, though itself very ancient, presupposes the existence of other schools and we have distinct mention of the Mahá-yána.* We now learn that the gradual fusion and amalgamation of Sivaite and Buddhist Tantras had begun even anterior to the sixth century. The Kubjiká-tantra was evidently composed outside India proper, probably in Nepal. The Goddess Párvatí encourages her consort to proceed to the continent for the spread of the tenets propounded by it. † In one place we come across a passage ‡ in which Siva himself speaks of páraða (mercury) as his generative prin-

* Catalogue of Palm-leaf and selected paper MSS. belonging to the Durbar Library, Nepal, by H. P. Sastri (1905). lxxviii, et seq.

दक्षिणे देवयानी तु पिण्डयानस्त्रीतरे ।

मध्यमे तु महाथाने ब्रिवसंज्ञा प्रबोधते ॥

† नन्द ल्वं भारते बैद्धिकाराम सुर्यतः ।

‡ महीर्यं यारहो यह पतितः क्षुटितं नविः ॥

महीर्यं प्रतुतासे तावार्यां तुनके वहि ।

तिहलि सुखृताः सतः भवा चक्र विप्रजारचान् ॥

For the passages cited here we are indebted to the industry and courtesy of Pandit H. P. Sastri, who has wended his way through the bulky MS.

ciple and eulogises its efficacy when it has been killed six times.* We also find allusions to the transmutation of copper into gold with the aid of mercury. In short, we have ample references to alchemical processes described in the very technical terms in which Rasárnava, Rasaratnákara and other typical works of the Tántric period abound. †

It is now only necessary to wind up this chapter with an extract from the work of an eminent Budhologist with this reservation that the growing influence of Tantrism began as we have seen long before the 8th century.

"The decline of Buddhism in India from the 8th century downwards nearly coincides with the

* Even at the present day mercury, which has been *killed* six times in succession, each time with an equal weight of sulphur चतुर्वर्षिकारित, is reputed to be one of the most potent of remedies.

† e.g. पश्चिम विहितो वेदः चिं व्यष्टती न विष्टते ।
रक्षित्वं बद्धा तादृ न भूयकामतां द्रवित् ॥

For the meaning of the word वेद (Vedha) see this Vol. p. 18, *footnote*, also Vol. i, p. 120.

Alchemy an integral part of Maháyánist activity.

growing influence of Tantrism and sorcery, which stand to each other in the relation of theory to practice. The development of Tantrism is a feature that Buddhism and Hinduism in their later phases have in common. The object of Hindu Tantrism is the acquisition of wealth, mundane enjoyments, rewards for moral actions, deliverance, by worshipping Durgā, the Sakti of Siva—Prajñā in the terminology of the Mahāyāna—through means of spells, muttered prayers, Samādhi, offerings, etc. Similarly the Buddhist Tantras purpose to teach the adepts how by a supernatural way to acquire desired objects, either of a material nature, as the elixir of longevity, invulnerability, invisibility, alchemy ; or of a more spiritual character as the power of evoking a Buddha or a Bodhisattva to solve a doubt, or the power of achieving in this life the union with some divinity. There is an unmistakable affinity between Tantrism on one side, and the system of Yoga and Kammatthāna on the other. Tantrism is, so to say, a popularised and, at the same time, degraded form of Yoga, because the objects are commonly of a coarser character, and the practices partly more childish partly more revolting.

"Tārānātha informs us that Tantrism existed and was transmitted in an occult manner in the period

between Asaṅga and Dharmakirti, but that after Dharmakirti's times the Anuttarayoga became more and more general and influential. Substantially his statement is certainly right. He adds that during the reign of the Pāla dynasty, there were many masters of magic, Mantra-Vajrāchāryas, who, being possessed of various Siddhis, performed the most prodigious feats.

"The kings of the Pāla dynasty, whose sway over Gauda and the adjacent regions lasted from about A. D. 800 to 1050, are known both from the annals and their inscriptions as protectors of the Faith. It was during that period that the monastery of Vikramasīla was a renowned centre of Tantrist learning.

"The Sena kings, who followed the Pālas in the dominion over Eastern India, though belonging to a Hindu persuasion, were not hostile to the Faith. Still Buddhism declined during their reign and more so after the invasion of the country by the Muhammedans in A. D. 1200. The monasteries of Udandapura and Vikramasīla were destroyed; the monks were killed or fled to other countries. The learned Sākyasīri went to Orissa, and afterwards to Tibet; Ratnarakshita to Nepāl; Budhāmitra and others sought a refuge in S. India, whilst Saṅgama-Srijñāna with several of his followers betook themselves to Burma, Camboja, etc.

And thus the Law of Buddha became extinct in Magadha.

"Many emigrants from Magadha rejoined their brethren in the South and founded colleges on a modest scale in Vijayanagara, Kalinga, and Konkan. The comparatively satisfactory condition of Buddhism in Dekkan about that time is attested by the rich donations to the monastery at Dambal."^{*}

It will be noted that the monks of the monasteries of Udaṇḍapura and Vikramasīla on their dispersion carried with them their learning and arts in the same manner of the

*Spread of al-
chemistry.* Byzantine Greeks on their expulsion from Constantinople bore with them their intellectual treasures to the Italian cities. In the kingdom of the Deccan and in Tibet the Buddhist refugees found hospitable asylums, † just as the Greek Philosophers did in the Florentine Republic under the Medicii.

* Kern—Manual of Ind. Bud., pp. 133—134.

† Cf.—"The Deccan, which from the eleventh century was the refuge and centre of literary activity generally. In Hindustan it had been substantially arrested by the inroads and ravages of the Muhammadans,—Weber. Hist. Ind. lit. p. 283.

Some eminent orientalists, whose opinions naturally carry weight, have hitherto taken for granted that the knowledge of chemistry such as we find reflected in the Tantras quoted by Mádhava in *Rasesvaradarsana** was derived by intercourse with the Arabs.†

* Vol. i, Intro. lxxviii, *et seq.*

† *E.g.* Barth : "In regard to alchemy, anyhow in which the Sittars are zealous adepts, they were disciples of the Arabians, although other Sivaites had preceded them in the pursuit of the philosopher's stone. Already, in his exposition of the different doctrines of the Saivas, Sáyana thought he ought to dedicate a special chapter to the *Rasesvara-darsana* or "system of mercury," a strange amalgamation of Vedantism and alchemy. The object contemplated in this system is the transmutation of the body into an incorruptible substance by means of *rasapána*, *i.e.*, the absorption into it of elixirs compounded principally of mercury and mica, that is to say, of the very essential qualities of Siva and Gaurí, with whom the subject of the operation is thus at length identified. This species of transubstantiation constitutes the *jivanmukti*, or state of deliverance commencing with this present life, the sole and indispensable condition of salvation. It is clear that the devotional formulæ of the Vedánta are here only a sort of jargon, under which there lies hid a radically impious doctrine ; and it is not less clear that in this doctrine, which had from the fourteenth century produced a rather considerable literature, there is an infusion of Mohammedan ideas. The Arabs of the Khalifat had arrived on these shores in the character of travellers or merchants, and had established commercial relations and intercourse with these parts long before the Afghans, Turks, or Mongols, their coreligionists, came as conquerors."—"Religions of India," ed. 1891, pp. 210-211.

The attentive reader who has followed us

In Tibet and the Deccan. all along could not have failed to notice that it was in the Universities of Nálen dá, Udaṇḍapura and Vikramasíla, in Central India and Magadha, precisely the regions which were cut off from communication with the external world, that Tantric mysticism with alchemy as an integral part was cultivated and from thence spread to Bhot (Tibet) and the regions lying to the south-east of it,* and South India.†

* See under colophons to *Rasahridaya* and *Rasasára* respectively.

+ The last rallying point of Hindu learning and sciences was the kingdom of Vijayanagara, which was in the heyday of its glory under Bukka I (A. D. 1354-1371) with Mádhava as his prime Minister. Wilson says :—“The history of Vijayanagara is a subject of considerable interest in the annals of India, as the last barrier that was opposed to Muhammedan invasions, and that preserved the southern part of the Peninsula from foreign rule until a very modern period.”—*As. Ecs.*, Vol. xx (1830), p. 1. See also Sewell’s “A Forgotten Empire”—(Vijayanagara).

CHAPTER II.

Having thus far prepared the ground for believing that alchemy along with other cognate branches of learning was the outcome of Indian intellectual activity, we shall now proceed to follow it up with its further deve-

Further cultivation of alchemy. lopment. At the outset it is, however, necessary to remember that on the decline of Buddhism the vigorous impetus which its followers gave to literature and science was not lost to India. Nay, during and after the revival of Brahminism under the Gupta dynasty and its successions we have some mighty intellectual giants whose productions will continue to shed lustre as long as the Hindu nation exists. Kálidása and Bhavabhúti, Brahma Gupta and Áryabhatta, Samkara and Rámánuja are names which may be regarded as the heritage not of India alone but of the entire civilized world. At the time of the Brahminic revival Buddhist works of acknowledged merit far from

being cast aside were held in veneration. Amarasimha in his Lexicon and Vágbhata in his *Ashtámgañahrídaya* * as also the pseudo-Vágbhata * commence with an invocation to Buddha, which has never shocked the tolerant spirit of the Hindu. Charaka and Susru-ta also bear distinct impress of Buddhist retouching. The Buddhist Trantras became likewise a part and parcel of Hindu religio-philosophical literature,† the subject-matter

Buddhist alchemical Tantras absorbed into Hindu Tantras. of the former was incorporated into the latter, the names of Tárá, Prajñápáramitá and

Buddha being simply changed into those of Párvatí and Siva. In Rasaratnákara itself we have distinct indications that it is an admixture of both.

* Vol. i, p. 76.

† Speaking of a typical Buddhist production belonging to this category Burnouf observes : "Ce morceau est exclusivement spéculatif, et il nous offre une nouvelle preuve de l'alliance intime que le système des Tantras a contractée avec la philosophie buddhique la plus élevée" (l. c. p. 543 ed. 1844).

It should thus be understood that the works under review in this chapter are based upon their Buddhist counterparts ; in short, there is no disposition to ignore the debt of obligation the authors are under to Nágárjuna, Ratnaghosha, Mándavya and others.

In the introduction to the first volume we stated : “It is to be regretted that the several works quoted by Mádhava [on the science of mercury] Rasárnava alone Rasahridaya seems to have survived to our days” (l. c. lxxxiii). Since then we have been fortunate enough to procure as many as three transcripts of MSS. of Rasahridaya by Govindabhagavat from different quarters. As Mádhava speaks of this author in terms of the deepest reverence and regards him as “ancient,”*we think we should not err on the wrong side if we place the author some three

* Cf. Vol. i, Intro. lxxx.

तद्यपचक्षु वौविष्वमनवत्यादाचार्यं उर्मलामित्ररम्भारकप्रवृत्तिमः
प्राचीनेराचार्यं निर्विपत्तिः ।

The qualifying epithet अवश्यक् is only applied to venerable Rishis of old.

centuries before his time. If our surmise be correct, he should have lived about eleventh century A. D. The only personal allusion which the author has condescended to offer for the edification of posterity is that he wrote his book at the request of the king of the Kirātaland, *i.e.*, the region adjoining modern Bhotan. Portions of this remarkable treatise after a careful collation of the MSS. have been reproduced in the proper place. The worm-eaten fragmentary MS. produced from Benares is 386 years old. Internal evidence equally goes to establish the antiquity of this work. The author was evidently a Buddhist as we learn from the colophon to the Benares MS. (*vide* trans. p. 12). It is, however, not to be found either in the India office or the Nepál MS. This important omission is easily accounted for. It is the reluctance of the latter day Hindus to acknowledge their obligations to a Buddhist author.

Rasārnava which has been noticed at length in the first volume and to which was assigned the 12th century A. D., as also Rasaratna-

samuchchaya (13th to 14th century), need not further arrest our attention.

The presentation of the various treatises of the Tantric and iatro-chemical periods under discussion in their exact chronological sequence is not an easy task ; in the absence of more definite information, we are afraid, we shall now and then have to hazard a conjecture.

The introductory lines of Books viii and ix of *Rasaratnasmuchchaya*, in which Somadeva is mentioned as the author of the descriptive part, led us to suspect that they are merely reproductions from "a standard work on the subject by Somadeva, no longer extant."* Our surmise has proved to be partially correct. We have at last been able to recover the supposed lost work. A transcript of a MS. of *Rasendrachúdámani* by Somadeva, preserved in the Library of the Deccan College, Poona, reveals to us the fact that

* Vol. i, p. 118.

practically all the important portions of this book have been woven into the text of Rasaratnasamuchchaya ; and this gives us an additional opportunity of collating many doubtful passages in both. But the present work itself does not lay claim to originality. It makes a candid admission that it culls all its materials from pre-existing chemical treatises.* It further puts forward the alchemist Nandi as the inventor of the process of sublimation and of the Koshthi apparatus (Vol. i, pp. 69 and 89).† Nágárjuna, Dandí, Sambhu and the sage Brahmajyoti are also spoken of as sources of his inspiration. We get very little inkling into the personal history of Somadeva, except that he was the ruler of a city named Karaválabhairava. The fact that R. R. S. lays Rasendrachudámani so amply under contribution would suggest that the latter had become somewhat rare

* अथ यत्तापि वल्लने रसरत्नास्मानेकमः ।

समाख्योक्त समासेन सीमद्वेन साम्रातम् ॥

† ऊर्जपातनयत्वं हि नन्दिना परिकौर्चितम् ।

कोहिकायन्नमितहि नन्दिना परिकौर्चितम् ॥

or that its contents had been well-nigh forgotten when the former was compiled. Its date may therefore be put down between the 12th and 13th centuries A. D.

Another important work of this period is *Rasaprakásá-sudhákara* by Yasodhara. The author of R. R. S. in the opening lines mentions the names of 27 alchemists to whom he is beholden, among which occurs that of Yasodhana. We have little doubt that the

Rasaprakásá-sudhákara. correct reading is Yasodhara.

We now find that there is very little original matter in R. R. S., it being made up of citations from *Rasárnava* and the works of Somadeva and Yasodhara. We should not, however, be understood to retract the high encomiums we thought fit to bestow upon R. R. S. for "its methodical and scientific arrangements of the subject-matter, which would do credit to any modern work."* Its author has never laid claims to originality, but, on the contrary, has freely acknowledged the sources he drew upon. The student of

* Vol. i, Intro. lxxvi.

Hindu chemistry, however, like a weary but devout pilgrim, must **wind** his way through intricate and thorny paths and feel ineffable joy at being able to approach the original fountain undefiled. It now transpires that the credit for the accurate observations on the metallurgy of zinc (Vol. i., pp. 88 & 156) really belongs to Yasodhara. While the author of B. R. S. always scrupulously admits that his work is a mere compilation, Yasodhara, on the other hand, is anxious to let the world know that the processes he describes have been verified by experiments performed with his own hands.* Among the authorities he cites are Nágárjuna, Devísástra (probably Rasárnava), Nandi, Somadeva, Svachchhanda-bhairava and Manthanabhairava. As Yasodhara quotes Somadeva, he must have been posterior to the latter by at least a hundred

* Of. सहस्र छातं सत्यक् जारणं न शुर्तं मया ।

सहस्रे भवदीनेन छातं सत्यक् शुर्तेन हि ॥

धातुव्यसृतीयोऽस्मि सहस्रे न छातो मया ।

हटप्रव्यवीगोऽयं कवितो गाच संश्लेषः ॥

years and he should therefore be placed in the 18th century A. D. *

Rasakalpa likewise seems to belong to this period. It is in the shape of Rasakalpa. a Tantra, but curiously enough it is not much troubled with consistency. In the opening salutation Siva, "the king of mercurial lore" and his consort Chandiká are reverentially bowed to—a procedure scarcely reconcilable with the position of a revealed document. The colophon at the end of each Chapter (उल्लास) claims the work to be a part and parcel of Rudrayámala Tantra; at the same time due acknowledgment is made to the contributions of Govinda, the author of Rasa-hridaya, Svachchhandabhairava and other adepts.† Towards the end the author says : "The processes described have all been verified by me and not borrowed at second-hand from my teachers." Needless to add here that the God Siva would not have

* We are using a copy of the MS. preserved in the Runbir Library, Kásmir. The readings are on the whole accurate.

† E.g. सर्वाचार्यदीक्षितः ।

been at pains in justifying the necessity of his production with such a timorous apology. From internal evidence it is abundantly clear that it could not have been composed earlier than the 13th century A.D.

As the author has confined himself solely to a description of the metals, minerals and the processes of "killing" them with the agency of various apparatus and has not gone into the treatment of diseases with the aid of mineral preparations, he has been able to condense much important information within the narrow compass of a few short chapters.

Rasarájalakshmí also deserves some prominence here not because of its intrinsic worth but because of the references to previous Tantras and alchemists, amongst which are Rasár-nava, Kákachandísvara, Nágárjuna, Vyádi, Svachchhanda, Dámodara, Vásudeva and Bhagabat Govinda. We have also categorical mention of the purely Ayurvedic works such

as Charaka, Susruta, Hárīta and Vāgbhata, to which our author is equally indebted.* From the colophon to the MS. procured from Benares we learn that the author Vishnudeva was Court Physician to king Bukka.† If this statement be accepted—and *prima facie* there is no reason to question it—this treatise must have been compiled in the latter part of the 14th century. Internal evidence equally supports this date.

* *Vide Sanskrit Texts*, pp. 80-81.

† *Vide ante.*, footnote, xl ix.

CHAPTER III.

c. 1350 A. D.

We now proceed to examine the contents of another series of works belonging also to the Iatro-Chemical period ; the one characteristic feature of which is that opium is recognised as an official drug in the *materia medica* portion. These may be taken to date from the middle of the 14th century A. D.

Rasanakshatramálikä by Mathanasimha, physician to the king of Malwa, should find a place in this chapter. For particulars as to the contents the reader may consult p. 22. The date given by the copyist of the MS. is Samvat 1557 i.e. 1500 A. D. The work itself is therefore older.

Rasaratnákara by Siddha Nityanátha, son of Párvatí, comes under this category.* The author gives the sources of his information and explains the object of his compilation.

* Two editions of this somewhat voluminous work have been published—one by Ganesa Chandra Ghose (Calcutta), .

tion in the following words : “Whatever has been revealed by Siva in Rasárnava under the preparations of mercury ; the Dípiká of Rasamangala on mercury ; all that has been said by Nágárjuna for the benefit of people afflicted with diseases, as also by Siddha Charpati, by Vágbhata and Su-
sruta,—all these and many other treatises on mercury and minerals being consulted, I have, after rejecting the drugs and medicaments which have become rare and difficult to procure, put together [in my work] the essential features thereof. * * * * All that I have learned from my teachers and have been in a position to subject to practical tests has been incorporated into my work for the benefit of mankind.” In addition to the authorities cited above Nityanátha quotes from Chakrapáni and Rasendrachúlámáni (*ante* liv.).

the other at the “Venkatesvara Press” (Bombay). We have compared the readings of these two editions with the MS. in the Library of the Sanskrit College, Calcutta. They agree fairly well.

Rasendrachintámani will next claim our attention. We have before us the printed copy, edited by Umesa Chandra Sena Gupta, late librarian, Sanskrit College, Calcutta, in which the text has been adopted, as the editor informs us in the preface, after collation of 3 or 4 MSS. We have carefully gone over this edition and compared its readings with those of a MS. procured from Benares and another from the Runbír Library, Kásmír. All these agree in the main, but there happen to be certain omissions and additions, which form an interesting chapter in the history of interpolations in the literature of this description. To begin with : there is a dispute over its very authorship. Some MSS. ascribe it to *Dhundhukanátha*, disciple of Kálanátha, others to Rámachandra. After the customary salutation there occur two couplets in the Calcutta edition, which are not met with in the Benares and Kásmír exemplars. In these the author is made to justify his *raison d'être* for undertaking his task in these words :

Rasendrachintámani.

“I shall give publicity only to such processes as I have been able to verify by my own experiments.” Such protestations have already been noticed more than once.* In another place we have : “Those mercurial operations alone have found a place in my book, which I have been able to put to tests. Those who teach without being able to perform experiments labour in vain.” This last couplet is quite out of place as it hangs like a tail to a long extract from Rasárnava and is in fact conspicuous by its absence in the Benares and Kásmír MSS.† For the second time we find calomel designated as Rasakarpúra (lit. camphor of mercury ; *vide* vol. i, p. 250). This preparation no doubt occurs in the older

* Such pretensions put forth on behalf of the author, especially in the first person singular, lead one to suspect that they are later interpolations. In the Arabian alchemy Geber is often made to declare to the same effect : e.g. “J’ai expérimenté moi-même tout ce que je rapporte.”—Berthelot, “La Chimie au moyen Âge,” t. 1, p. 338. The well known egoistic couplet in Susruta, Ch. i, यह हि व्यवस्थितादिदेवः is generally regarded as an interpolation.

† The extract commences with तं भासा सर्वेषु सामान्.

works, *e. g.* *Rasárnava*; but it is described there as the white "ash" of mercury (*svetabhasma*). The recipé for calomel as given in the Calcutta edition, however, is quite different from that in the Benares and Kásmír MSS. and it is altogether wanting in one of the MSS. in the Calcutta Sanskrit College Library. We are therefore not without suspicion that it has been foisted into the original composition. The author refers to *Rasárnava*, Nágárjuna, Govinda, Nityanátha, Siddha Lakshmisvara, Trivikramabhätta and Chakrapáni. There is a lengthy colophon but no direct information can be derived from it as to the age of the author.

Rasasára : It is a comprehensive but purely chemical work dealing with 18 operations on mercury; various chemical processes are incidentally described, a good many of which, however, overlap each other. There does not seem to be any justification for coining a multiplicity of technical jargons to connote each of these. But prolixity was never regarded in the light of a vice by the

alchemical writers of the middle ages either in India or in Europe. The contents of *Rasasára* often remind us of a poem on alchemy by George Ripley, canon of Bridlington in Yorkshire (b. about 1460), of which Rodwell says :—

“But we cannot point to a new fact which he elucidated. He divided all chemical operations into twelve processes—calcination, dissolution, separation, conjunction, putrefaction, congelation, cibation, sublimation, fermentation, exaltation, multiplication and projection. Several MS. copies of his poem exist in the British Museum, bound up with copies of the works of Roger Bacon and earlier writers. Here is a specimen of his rugged rhymes :—

The first chapter shall be of natural *Calcination* ;
 The second of *Dyssolution*, secret and phylosophycall ;
 The third of our elementall *Separation* ;
 The fourth of *Conjunction* matrimoniall ;
 The fyfth of *Putrefaction* then followe shall :
 Of *Congelation Albyfactive* shall be the Sixt,
 Then of *Cybation*, the seventh shall follow
 next.”*

* *Vide “Birth of Chemistry”.*

The author, Govindáchárya, as a devout Hindu, begins with his adoration of Siva and Vishnu and tells us at the outset that his treatise is a compilation and epitome based upon standard works on the subject and the contributions of the adepts. We have every reason to be thankful to him for the many hints he throws on the sources of his information. Of surpassing interest is his declaration that for a knowledge of certain processes he is indebted to the Buddhists of Tibet.* This must be taken to mean that the cultivation of alchemy had become neglected and almost forgotten in India proper and the earnest searchers for this lore had to repair during the time of our author to Tibet. Confirmatory evidence to this effect is equally

* एवं वौद्धा विजाननि माटदेवलिकासिगः ।

Towards the close of his work the author again acknowledges his obligation to the Buddhists.

पौद्धमते तथा चाला रससारः इती यता ।

We have in our possession five transcripts of the MSS. of Rasaśāra procured from the Libraries of Kásmir, Tanjore, Ulwar, Madras and the Temple of the Goddess Kálí, at Ramná, near Dacca, Bengal.

furnished in the colophon to *Rasahridaya* (trans. p. 12). During the decadence of Buddhism and the corresponding ascendancy of Brahminism in Bengal, say about the 11th to 13th centuries A.D., this branch of science also found a safe retreat in the land of the Kirátas as we have already seen. Burnell, under the influence of his preconceived notion, namely that Indian alchemy owed its origin to the Arabs, very naively remarks : “By *Baudhas* he (the author) probably means the Muhammedans (*of.* the vernacular *Malayálam* use of the word), though studies of this nature were much pursued by the later Buddhists.”*

Some idea of the date of *Rasasára* may be formed from the fact that there is mention of opium in it. But our author was evidently quite in the dark as to its origin ; for, says he : “There are 4 different kinds of poisonous

* Catalogue of the Tanjore Palace MSS. pt. 1, p. 70. Burnell draws his conclusions from the reference to Buddhists in the colophon ; but we have quoted above another passage in which distinct mention is made of the Buddhists of Tibet.

sea-fish, and it is from their foam that 4 different kinds of opium are derived, namely, white, red, black and yellow ; while others maintain that it is derived from the foam of the snake and it is very properly used for chemical operation,”* e. g.,—killing and fixation of mercury. From the context it is, however, doubtful if the narcotic drug is really alluded to here. But independently of the use of this term we may safely place this work in the 13th century A. D.

* समुद्र चैव जायने विषमस्त्वाचतुर्विंशः ।
 तेभ्यः फेनं समुत्पद्मं अहिफेने विषं स चतुर्विंशं ।
 केचिददन्ति सर्पाणां फेनं स्वादहिफेनकं ।
 यथा—धारणं श्वेतवर्णं च रक्तवर्णं च जारकं ।
 सारणं पीतवर्णं च लालवर्णं च मारणं ।
 विषविद्वत्तमं फेनं युज्यते रसकर्मचिं ।

The Sanskrit word for opium, “ahiphena,” lit., foam of the snake, is of modern date. It is generally held that this word has been Sanskritised from the Arabic “aphiyún.”

These indentical distichs also occur in the commentary on Sārngadharā by A'dhamalla with the additional line, वाष्णः (वाष्णः) औरविशेषः, namely, it is the milky juice of poppy ; proving that during the time of the latter its real origin was known, at the same time its supposed origin was not disbelieved.

Sáringadhara-samgraha—a compilation by *Sáringadhara* : its peculiarity is that it is based upon the A'yurvedas (Charaka, etc.) on the one hand and the Tantric chemical treatises on the other. In the chapter on the purification and incineration of metals, 7 of these are recognised, but strange to say there does not occur any mention of zinc. Later on, 9 metals are named including two alloys, brass and bell-metal, after the 9 planets, the significance of which will be discussed in the proper place.

The date of *Sáringadhara* can be ascertained with accuracy, as besides this medical compendium he is the author of the *Pad-dhati*, a voluminous miscellany, containing, with other matters, a poetical anthology. The author dates his work in *samvat* 1420 or A. D. 1363. The name of the author's father is Dámodara and that of the grandfather Rágavadeva. The latter was highly considered by Rájá Hammíra, the Chauhan.*

* After the sack of Chitor by Alla-ud-din in A. D. 1303, Mewar was occupied by the garrisons of Delhi. Hammíra

There is a big commentary on this work by A'dhamalla, whose ancestors settled in the city founded by Hammíra.*

Rasendrasárasamgraha : The author, Gopálakrishna, begins by admitting that his treatise is a mere compilation based upon many Tantras, though he mentions by name only two, namely, Rasamañjari and Chandriká. Special stress is laid on the therapeu-

recovered his ancestral throne and during his prosperous rule of sixty-four years (1301-1365) and that of his successors arts and literature found liberal patrons (*vide* Tod's "Annals of Rájastan"). The court of Hammíra attracted another distinguished physician named Saugata Simha as we gather from the colophon to a noted recipé.

एषा सौगतसिंहाक्षमिवजा खोके प्रकाशीकरता

इच्छीराय महोमुखे * संस्कृतभाजि मृग्म् ।

* A'dhamalla gives an account of his family. His Grand-father was one Chakrapáni, not to be confounded with the celebrated medical author of Bengal (Vol. i, Intro. liv) and he himself was attached to the court of a ruler named, Jaitrasimha, whose capital Hástikántapuri was situated on the river Charmanvatí. We reproduce in the next page the text which is somewhat corrupt from the copy preserved in the Library of the Sanskrit College, Benares.

tic efficacy of mineral preparations.* Like Rasendrachintámani it assigns a minor place to the ancient Ayurvedic method of treatment by kasháyayoga, i. e., by herbs and simples ; as far as the knowledge of chemical processes goes, it must be held inferior to the former. Numerous medicinal recipés

श्रीवास्तव्यकुलमकाशमध्ययी ये पूर्वजा विनियोगः

श्रीहन्दोरपुरी * * * *

तदन्वये किं बडुना प्रसिद्धशीचकपाचिः कुलकेरवेयुः(कुः)

* * * * * * * *,

तस्म तु त्रिसुभगस्य तनूजो भावसिंह इति भूपतिमानः ।

* * * * * * * *

तस्याम्बजो दोषंमति प्रहृष्टो नाकाढमहो * *

तेज * * वीगामस्ते (?) (विनायते) शार्ङ्गधरमकाशः ।

ज्ञासीकालपुरी पुरा पुरगिता काशीय विद्यमै-

र्याहा यथ सरः सरिहृष्वरा चर्ष्णस्तौ पापहा ।

यस्यां हइतवासुदैवचरवद्याम्बुजः आपतिः

स्थाती धर्यैवात्ति धर्यैवतितु श्रीकैवसिंहः प्रभुः ॥

तस्या शार्ङ्गधरीकाणां वीगाणां च प्रकाशिणी ।

क्षिवसे साधमज्जेन संहितायाः प्रदीपिका ॥

* For a description of some of these vide "Journal des Savants," April, 1898.

agree word for word with those in *Rasendra-chintámani*, which only proves that both have drawn on a common stock. There is no question of the one borrowing from the other, as internal evidence proves that both belong to the same period. *Abhayánanda Gupta* in the preface to his edition says :—“There is a tradition to the effect that *Gopála Kavibhú-shana* of *Dakshina Vāṅga* is the compiler of this book ; but this can scarcely be accepted as he lived not long ago.” Again. “Its commentator, *Rámasena Kavindramani* (author of *Arthabodhiká*) was court physician to Nawáb Jaffer Ali Khan of Bengal (Mir Jaffer) some 200 years ago.” *Rámasena* himself quotes from 3 commentaries of this book ; hence it was recognised as of some degree of importance at that time and must have been composed long before. This work is very popular in Bengal and is a *vade mecum* of the local *Kavirájas*.

Rasendrakalpadruma is another work of this period. It deals chiefly with mineral preparations and is a mere compilation from

Rasárnava, Rasamaṅgala, Ratnákara, Rasámrīta and Rasaratnasamuchchaya ; the numerous citations with which it is replete are of some use in correcting many doubtful readings in these latter. Our MS. is incomplete, the first few couplets and the sequel being lost ; for the opening lines of the work see Aufrecht's Catalogue of the Bodleian Library, MSS., pt. 1, p. 321.

Dhátruratnamálá : This epitome is devoted exclusively to short processes of *killing* metals and minerals. Six metals are recognised at the outset, namely, gold, silver, copper, lead, tin and iron as in the ancient works; but strange to say later on *kharpara*,* which is the mineral calamine, is taken as synonymous with jasada or zinc. We have before us a MS. procured from Benares. It is full of corrupt readings. The copy noticed in the Bodleian Library Catalogue seems to be more correct. From the colophon in the latter we learn that the author is one Devadatta of Gujarátā, but in the Benares exemplar

* Vol. i. p. 158.

this portion has been coolly tampered with, so that this poor compilation may be palmed off as an integral part of a *Samhitā* of the *Asviníkumáras*, the divine physicians, and thus entitled to the respect due to revelation. This work cannot be placed earlier than in the 14th century. Here we have a serious sidelight into the history of literary forgeries.

CHAPTER IV.

MODERN PERIOD.

1500—1600 A. D.

We have now arrived at what may be termed the modern period in Hindu chemistry and *materia medica*. The characteristic of this period is that over and above opium, we have some other foreign drugs incorporated into the *materia medica*. By the beginning of the 16th century A. D. the Portuguese had fairly established themselves at Goa and some other parts of India,* and as a result of intercourse with them, that dreadful scourge—the venereal disease—had made its appearance. Sanskrit medical treatises from the Charaka and Susruta downwards and ending with *Sáringadhara* are silent about this malady though they give fairly

* The political influence of the Portuguese as early as 1533 A. D. is evident from the fact that Sultan Bahadur, king of Gujarát, entered into a treaty with them and through their assistance raised a force of 6,000 Abyssinians—"Memoirs of Humayun".

accurate descriptions of diseases of the genital organs (उपर्दण). But syphilis had now to be reckoned with and a new name had to be coined for it. Accordingly we find Rasa-pradípa, one of the standard works of this period given to Tantric method of treatment, prescribing calomel and *chobchini* (China root, *Smilax China*, Linn) for what is now termed for the first time *Phirangaroga* or the disease of the Portuguese. According to Flückiger and Hanbury "the use of this drug as a remedy for syphilis was made known to the Portuguese at Goa by Chinese traders about A. D. 1535." Thus from an independent source we can arrive at the approximate date of Ras pradípa. This work also gives us a detailed process for the preparation of mineral acids by distillation which is here termed *samkhadravaka* (lit. a solvent for conch shells) and is described as "endowed with the property of dissolving metals." It is thus evident that the use of mineral acids as a solvent for metals was unknown in India before this time.* A very

* *Vide Note on mineral acids, vol. i. p. 185.*

noteworthy circumstance in connection with this is that the Bhávaprakásá, which is posterior to Rasapradípa, is silent about sam-khadrávaka, which had come to be prescribed by this time as a favorite remedy for indigestion and derangement of liver and spleen ; the solvents being borax, treacle, etc.—(cf. vol. i, p. 130). In the Bhávaprakásá among the acids we have only the juices of acid fruits. This is only another instance of the danger one is liable to incur by drawing inferences from *argumentum ex silentio*.

Rasakaumudí is another compilation belonging to this period and as far as its contents go it is comparable to Rasapradípa in many respects ; both opium and mineral acids are prescribed. From the colophon in the Calcutta Sanskrit College Library MS. we gather that the author is a physician named Mádhava. Curiously enough he is often confounded with the celebrated Mádhavaka, the author of the Nidánasamgraha, who preceded the former by some 8 or 9 hundred years.

The next work which should now claim our attention is the well known Bhávaprákásá of Bhávamisra. It is a voluminous compilation in which the Ayurvedic method of treatment has been mainly adopted and as such ample citations are given from the Charaka, Susruta, Vñgbhata, Háríta, Vrinda and Chakrapáni. But the Tantric remedies could not altogether be given a wide berth and accordingly one or two chapters have been devoted to mineral preparations ; but these have been borrowed chiefly from Rasa-pradípa, Rasendrachintámani, Sáringadhara and other standard works. Bhávamisra has been scrupulously candid in his acknowledgments to the various authorities quoted by him. *Phirangaroga* is mentioned as also its treatment with the help of calomel and *chob-chini*. The author lived about the time of the Emperor Akbar and evidently in that part of India which is now known as the United Provinces and it is not to be wondered at that Mussulman influence is discernible in his book.

We conclude our survey of this period.

with the notice of a remarkable production entitled Dhátukriyá or “operations with metals”; it is in the shape of a dialogue between Siva and párvatí; in short, it pretends to be a part and parcel of the Rudrayámala Tantra.* The work cannot be placed earlier than in the 16th century A.D., as it contains reference to the country of the *Phirangas* and to Rúma, the Arabic name for Constantinople. For the first time we come across the very appropriate term dáhajala (lit. burning water) coined to denote sulphuric acid. The information about the metals is of very meagre and poor description and it has been needlessly spun into an inordinate length. The author evidently cosiders it a pious fraud to make such statements as follow emanate from the mouth of Siva himself :—

“By using coins made of imitation gold one can carry on exchange . . . and thus enrich oneself.”

* We have in hand transcripts of two MSS.—one from the Library of the Mahárájá of Ulwar, the other named somewhat differently, Dhátumañjari, from Benares. They agree very closely.

The curious reader who is referred to the translations of the selected portions of the text given elsewhere will not fail to recollect similar passages in the Leyden Parchment where the dishonest goldsmith gives numerous recipes for “augmenting gold.” * Fraudulent attempts in the direction of palming off alloys of base metals, possessing bright, yellow lustre, for gold, have been made in all ages and in all climes (*cf.* extracts from *Rasárnava*, Vol. i, p. 74).

Arkaprakásā or a treatise on the preparation of medicinal tinctures and essences should also find a place here; † its authorship is ascribed to Rávana, the mythical king of Ceylon. The contents of the work, however, reveal its date. For instance, mercury, treated with *S'amkhadrávaka*, is prescribed as the remedy for “*Phiraṅgaroga*” (syphilis).

* Berthelot : “Collection des Alchimistes grecs” (trad. p. 287). “La Chimie au Moyen Âge,” T. I. p. 31.

† There is a Calcutta edition published by Ganesa Chandra Ghosha; we have compared it with a MS. procured from the Sanskrit College, Benares. They agree remarkably well.

Opium also is prescribed ; while the term *yasada* is used to indicate zinc. As a distilling apparatus a tinned copper vessel is recommended. Mahomedan influence is distinctly discernible in this hybrid production. The very title of the book is no doubt Sanskritised from the Persian *arrak* (essence).

It is unnecessary to proceed further. We have before us the MSS. of *Rasamañjarí* by Sálinátha, of *Rasarañjana*, of *Gandhaka-kalpa* (a Tantra), of *Rasárnavá* (quite distinct from the standard work bearing the same title), of *Rasaratnákara* (altogether different from that of Nityanátha) and several others. As all of these repeat *ad nauseam* the processes already described, we refrain from examining their contents here.

CHAPTER V.

INDIGENOUS ORIGIN OF INDIAN ALCHEMY.

The reader who has been able to follow us throughout with patience will not have been slow to recognise that alchemy in India has been developed all along on independent lines. Its origin and growth are interwoven with a phase of religious activity—the outcome of purely indigenous traits—which has been discussed at length in chapter i.

The only instance in which we find some allusion to adepts outside the pale of Hindu institutions occurs in Rasaratnasamuchchaya.* But the term Mlechchha used there is a generic one applied indiscriminately to

* म्लेच्छकसामाज्. *Vide* Vol. i, Sans. texts, p. 56; a variant in the Poona edition has मेलकसामाज्, which must be rejected as both the Benares and Kasmir MSS. accept the former.

the *Sakas*, the *Yavanas* (Greeks or Bactrians), the *Chinas* (Chinese), etc. The Hindus have never been shy of acknowledging their obligations to the *Yavanas*; *Varāhamihira* for instance expresses his admiration for the proficiency of the latter in the field of astronomy and would gladly learn at their feet.* In the *Mahābhārata* again we find the services of the *Yavana* architect, *Purochana*, requisitioned. We have not, however, come across a single passage, which may be construed into implying a hint to alchemists in the West. That the term *Mlechchha* in R.R.S. really refers to the *Kirātas* is evident from the colophon to *Rasahridaya*. †

Those scholars who have hitherto maintained that Indian alchemy is of exotic origin, have, we are afraid, done so on *a priori*

के व्या हि यवनासेषु सम्बू शास्त्रमिदं स्थितं ।
चतुष्वर्णेऽपि पूज्यनो किं पुनर्देवविहृतः ॥

* Sans. texts, p. 39; there the four castes (*चतुर्वर्ण*) are distinctly mentioned and the *Kirātas* evidently included under the *Mlechchhas*.

hitá, if anything, is a repertory of astrological notions. In vain do we look even there for any such chance and solitary reference.* The alchemical literature of India is equally silent about it. † True it is there are two metals which are often designated as the sun and the moon respectively, namely copper

* Chapter xvi of this work treats of "countries, people and things belonging to the domain of each planet." Among sundry other things "the Sun is the lord of gold and fire." Thousand and one articles are said to be presided over by the Moon, Mars, Mercury, Jupiter, Saturn, Venus, Ráhu and Ketu ; but nowhere is there any connection between the planets and the metals. *Vide* Kern's trans., pp. 97—101.

† The mythical origin of some metals is given in the Puráṇas ; but no reference to the astral bodies is to be found. Thus silver originated from the tears of the God Siva, copper from the semen of the God Kártikeya, lead from the semen of the Snake God Vásuki, iron from the different parts of the body of the demons called Lomilas ; and gold from the semen of the God of fire. Some vague and remote connection only can be established between this sort of nomenclature and that of the old Greco-Egyptian alchemists. According to the latter mercury is sometimes designated as the semen of Hermes ; whilst in the Tantras it is the semen of Siva (श्रीमति). *Vide* "Intro. à l'étude de la chimie des anciens," p. 11.

and silver.* But this has nothing to do with the planetary generation of these metals. In the imagery of the Sanskrit poet the crimson tint of the rising sun and the pale white lustre of the moon are comparable to the colour of copper and silver respectively.

The old Greek writers repeatedly refer to the mystic relationship between the seven planets and the seven metals. In the Sanskrit literature, however, beginning with the *Susruta* and coming onwards to *Rasaratna-samuchchaya*, we invariably find six metals recognised, alloys being rigorously excluded from the list and regarded simply as "artificially made." † It is only in the *Sáringadhara* and other later works that we find seven metals enumerated ; ‡ but this author

* रवि, अर्द्ध and other synonyms are as a rule applied to copper but rarely to gold.

† *Vide Vol. i, pp. 48, 72 and 127.*

‡ (चार) brass being taken as the aditional metal ; since was evidently unknown to *Sáringadhara*.

सुर्वतारारतामाप्ति नामवहौ च तीक्ष्णकम् ।
चातुरः सप्त विशेषाः ।

is guilty of a curious inconsistency, since in a subsequent part of his book he adds two more to the list and quietly lays down that there are nine metals, *which derive their names from the nine planets.** This may be read as a sort of vague and indistinct connection between the metals and the astral bodies.

The Arabs who adopted many of the Greek doctrines of alchemy also represented the seven metals by the seven planets. In fact it was through the medium of the Arabs

* "Kámsya" (bell-metal) and "Vrittaloha" or "Varataloha" (*cf.—Vol. i. p. 114*) make up the number. Ráhu and Ketu are the two mythical planets; they are in reality the ascending and descending nodes in the ecliptic. Ráhu is supposed to cause the eclipse of the sun and the moon by swallowing it up.

Sáringadhara stops here, but his prolix commentator, A'dhamalla supplies the deficiency by making copper stand for the Sun, silver for the Moon, brass for the Mars, iron for Saturn, gold for Jupiter, tin for Venus, lead for Mercury and bell-metal and vartaloha for Ráhu and Ketu respectively.

It will also be noticed that lead is here represented by Mercury; but in the Hindu alchemy mercury always stands as the visible manifestation of the God Síva, it being generated from his semen, hence the name वर्षेश given to it.

and the Jews that a knowledge of the Greek sciences including alchemy filtered to the European nations during the middle ages.* We have already seen that Rājputāna had been overrun and even occupied for a brief period by the Mussulman conquerors shortly before the time of Sárṅgadhara and it is reasonable to suppose that he had gleaned some astrological notions from that quarter.

We now advert for a moment to the main question of the connection of the comparatively modern and scientific phase of Hindu astronomy with the science of Alexandria. Although it is admitted by all those who are entitled to speak with authority on the subject that the Hindus borrowed from the Greeks and thus improved upon their older system, many points have yet to be cleared up. Professor Whitney who has

* "C'est par l'intermédiaire des écrits arabes et hébreux que la plupart des connaissances scientifiques des Grecs en mathématiques, en astronomie, en physique et en médecine, ont été transmises au moyen âge occidental ; les écrits Grecs proprement dits n'ayant guère été connus directement avant la Renaissance."—"La chimie au Moyen Âge," T. i. p. 229.

carefully studied the subject is struck with the circumstance that the Súryya and other Siddhántas bear resemblance to the system of Hipparchus rather than that in the Syntax.* In other words the transmittance of astronomical knowledge must have taken place before the time of Ptolemy. Now the period of lively intercourse is precisely that covered by the age of Ptolemy and that of his followers, and yet the Indian astronomers seem to be unaware of his teachings.†

* Intro. to "Súryyasiddhánta". We find from Ptolemy that the observations of Hipparchus extended from B. C. 162 to B. C. 127. Ptolemy flourished at Alexandria in the second century A. D. under the reigns of Adrian and Marcus Aurelius.

This was also pointed out long ago by Colebrooke, e. g. "The whole cluster of astronomers mentioned by Brahma Gupta must be placed in the interval between the age of Hipparchus, and possibly that of Ptolemy."—Essays, pp. 411—412.

+ A'ryabhatta composed his treatise "Laghváryabhatti-yam," in 496 A. D., and Varáhamihira his "Pañchasidhdhántiká" about 550 A. D. But these astronomers borrowed from the much older treatise entitled "Romakasiddhánta" ascribed to Sríseña, and Paulisasadhdhánta (*vide* Thibaut' Intro. to Pañchasidhdhántiká, xxvii—xxvi).

This mystery has never been elucidated ; Dr. Thibaut's arguments are ingenious, but, we are afraid, by no means convincing.* Indeed in the purely mathematical sciences the Hindus far excelled the Greeks of the Alexandrian school. A'ryabhatta's knowledge of algebra was superior to that of Diophantus and as for arithmetic it is generally acknowledged to be of Indian origin.†

The last word on the subject has yet to be said and it is doubtful if this dark recess will ever be illumined. In the meantime it would be better to hold our judgment in abeyance. At best we can only launch into hypotheses

* L. c., pp. li and liii.

† Cf.—Colebrooke : "Admitting the Hindu and Alexandrian authors to be nearly equally ancient, it must be conceded in favour of the Indian algebraist, that he was more advanced in the same."—Essays, ii, 429. Again, "in the whole science he [Diophantus] is very far behind the Hindu writers," *ibid.*, p. 438.

Kaye has recently questioned the priority of the claims of the Hindus : *Vide J. A. S. B.* iii [N. S.], July, 1907.

or indulge in dogmatic assertions.*

* One who approaches this subject should divest himself of prepossessions or the "bias of patriotism" as Herbert Spencer puts it. A very agreeable feature in this controversy is that those who are most competent to speak with authority are extremely modest, nay diffident in giving expression to their views. Woepcke in his masterly memoir "on the propagation of the Indian numeral symbols" says :—"La solution parfaite de ces problèmes ne résulterait que d'une connaissance tellement complète des événements et de leurs phases, qu'il faut à peu près renoncer à jamais l'obtenir. D'un autre côté, remplir les vides par des hypothèses arbitraires au préconcues serait livrer l'histoire des sciences eux hasards et au dogmatisme des inspirations individuelles." "Journal Asiatique" (1863).

Lassen whose modesty is only equalled by his profound scholarship observes :—Es wäre sehr wünschenswerth, dass ein mit der gehörigen Kenntnifs der Sanskritsprache ausgerüsteter Kenner der Mathematik und Astronomie es unternähme, aus diesen vorhandenen Hülfsmitteln die Lücken unserer Kenntnifs auf diesem Gebiet des Indischen Alterthums auszufüllen ; für jetzt müfzen wir uns darauf beschränken, die hauptsächlichsten Ergebniffe der bisherigen Untersuchungen zusammenzustellen." "Indische Alterthumskunde." Vol. ii. p. 1150 ; ed. 1874.

CHAPTER VI.

SOME NOTED INDIAN ALCHEMISTS AND THEIR WORKS.

Aufrecht in his notice of the MS. of *Rasaratnasamuchchaya*,* evidently from a mistaken notion that the pursuit of chemistry was unknown in ancient India, goes somewhat out of his way in asserting that the names of the 27 alchemists, mentioned in the beginning of that work,† are mostly apocryphal. We have, however, positive proofs that these personages far from being evolved out of the imagination of the author existed in real flesh and blood and contributed not a little to the progress of chemical science. Thus we read in *Rasaratnákara* of "chemical operations performed by Mánadvya" and also find Ratnaghosha taking part in a dialogue on certain processes, ‡ Yasdharma, again, is the author of the comprehensive work named *Rasaprakásasudhákara*.

* *Catalogus Catalogorum.* ii. p. 116.

† *Vide Vol. i, p. 77.*

‡ *Eng. trans.* pp. 6—8.

which we have noticed at some length in the present volume. 'Vyádi is a prominent name both as a grammarian as well as a chemist. The "Garudapurána quotes him as an authority on gems.* 'Nandí, as we have already seen, is distinctly referred to by Somadeva as the inventor of the *koshthi* apparatus and of the process of sublimation. †

There are, indeed, a great many names scattered throughout the mass of chemical and medical literature, some of which have been handed down to posterity, sometimes on account of the important processes they invented and sometimes, again, because of the efficacy of the metallic preparations which they introduced. Thus in Rasendra-chintámani we come across the name of Siddha Lakshmísvara. The names of the sage Brahmajyoti, 'Manthánabhairava,' Svacchhandahhairava and "Gahanánandanátha have in this manner been rescued from oblivion. Most of these were Buddhist monks.

* व्यादिजंगाद जगता हि लक्ष्मीप्रभावः सिद्धी विद्युष्विततव्यरवा दद्याक्षुः ।

† Intro., iv.

"Sivadāsa in his commentary on Chakrapāṇi quotes besides Patañjali, Bhavyadattadeva as an expert on iron preparations. We give below the names of some of the authors and their works over and above those already noticed. It is scarcely possible to submit an exhaustive list.

Name of the Author.	Name of the work.
Ānandānubhava	Rasadīpikā.
Balabhadra	(Unknown).
Bhojadeva	Rasarājamrigāṅka.
Chandrasena	Rasachandrodaya
Charpata	Charpatasiddhānta.
Dhanapati	Divyarasendrasāra.
Garudādattasiddha	Rasaratnāvalī.
Gorakshanātha (Unknown)	Gorakshasamhitā.
(Unknown)	Baudhasarvasva.
Harihara	Rasesvarasiddhānta.
Kaṅkālī	Rasavisvadarpana.
Kapālī	Rasakaṅkālī
Kesavadeva	Rasarājamahodadhi.
Mallāri	Yogaratnākara.
Narahari	Rasakautuka.
Rāmarāja	Rasayogamuktāvalī.
(Siddha) Bhāskara	Rasaratnapradipa.
(Siddha) Prānanātha	Rasendrabhāskara.
Srīnātha	Rasadīpa.
Trimallabhatta	Rasaratna.
Vaidyarāja	Rasadarpāna.
Vandimiera	Rasakashāyavaidyaka.
Vāsudeva	Yogasudhānidhi.
	Rasasarvesvara.

The Tantric Period

(Continued).

Chemistry in Rasaratnakara of Nagarjuna.

[In the rendering of Rasaratnākara of Nāgārjuna and other Sanskrit texts we have often given only free translations. Such passages as are unnecessary repetitions or are not of sufficient interest to the general student of the history of Chemistry have been left out.]

CHAPTER 1.

I shall now speak of the purification of the important rasas* (minerals).

What wonder is it that rājāvarta digested with the juice of *Acacia sisira* converts silver of the weight of one guñja into one hundred times its weight of gold of the lustre of the rising sun ? 1

* Regarding rasas see Vol. 1, p. 79.

What wonder is it that yellow sulphur, purified with the juice of *Butea frondosa*, converts silver into gold when roasted thrice over the fire of cowdung cakes ? 2

What wonder is it that calamine.....roasted thrice with copper converts the latter into gold ?* 3

* These laconic recipes all refer to the floating mass of traditions current at the time of the author on the transmutation of the base metals into gold. As they are of a fragmentary and disjointed character, the meaning is not always clear. Recipe 3 also occurs in *Rasārṇava*; *vide* Vol. i, pp. 70-71. Various ingenious methods were resorted to for debasing gold or making an alloy, which would mimic the appearance of this metal. Silver, copper, lead, zinc and mercury were often made into an amalgam, and the latter rendered compact and coloured yellow with the aid of orpiment. No wonder that the law-books prescribe several penalties on the fraudulent debasers of the precious metals. Thus according to Manu "the king shall cause a goldsmith, who behaves dishonestly, the most noxious of all the thorns, to be cut to pieces with razors." IX, 292.

The reader who feels interest in this subject may consult Berthelot's "La Chimie au moyen âge," t. 1. pp. 31 *et seq.*, where will be found several recipes for augmenting gold *aurum plurimum facere*, or for the "fabrication of gold." One example may be cited here. "Take gold, copper and mercury, make an amalgam of the whole, afterwards add sulphur, orpiment, "sandarac" (a kind of resin) and the bile of the vulture &c." The author of the recipe thus concludes :—"Thou wilt now discover a secret, which is sacred and worthy of praise" (l. c. p. 35).

What wonder is it that cinnabar digested several times with the milk of the ewe and the acids* imparts to silver the lustre of gold glowing as saffron ? 4

Digestion [of minerals] is to be effected in the decoction of *Dolichos uniflorus*, *Paspalum scrobiculatum*, the urine of man and the acid juices of [the fruit of] ratan (*Calamus rotang*) and afterwards with the addition of the alkalies (soda, borax &c.) The operation of roasting is to be performed thrice.—Cf. the process of Rasaratnasamuchchaya (R. R. S.), Bk. ii, 67-68 in Vol. i, p. 83.

What wonder is it that the pyrites macerated in the juice of *Musa sapientum* and in castor oil and clarified butter, and placed inside the bulb of *Arum campanulatum* and roasted [in a closed crucible] undergoes perfect purification ? † 6

Chapala and other minerals, being macerated in the juice of the lemon for 3 days, become purified. Gold being smeared with the 5 earths, the ashes and salts ‡ and roasted, undergoes purification. 12.

* Vegetable acids are meant here. *Vide* Vol. i, p. 128.

† Here extraction of copper from the pyrites is no doubt meant.

Cf. R. R. S. Bk. ii, 89-90; *vide* Vol. i, p. 84.

‡ Cf. R. R. S. Bk. x, 71, 85; *vide* Vol. i, pp. 128-129.

Silver alloyed with lead and fused with ashes becomes purified.* 13

Lo ! it is not to be wondered at that copper, melted with the alkali derived from the earth† and the milk of the ewe, clarified butter and one-sixteenth of its weight of oil, will become pure like the crescent of the moon. 14.

Verses 23-25 : Extraction of the essence of vaikrānta : exactly the same as in R. R. S. Bk. ii, 71-72. *Vide* Vol. i, pp. 83-84.

Verses 25-30 : Have reference to the extraction of copper from mākshika and tāpya (varieties of the pyrites). They agree in all essentials with Rasārnava, Ch. VII, 12-13. *Vide* Vol. i. p. 70

Verses 31-32 : Extraction of zinc from calamine. Cf. R. R. S. Bk. ii, 163-164. *Vide* Vol. i, p. 88.

Verses 35-36 : Exactly the same as in R. R. S. Bk. ii, 103-104. *Vide* Vol. i. p. 85.

Verse 37 : Essence of darada, *i. e.* extraction of mercury from cinnabar by distillation. Cf. R. R. S. Bk. i, 89-90. *Vide* Vol. i, p. 78.

* Refers to cupellation. Cf. Rasārnava in Vol. i, p. 68, foot-note (1).

† वृक्षीभवेन चारेण may refer to natron or to saltpetre.

Verases 50-51 : Dissolution of gems (pearls &c.) by digestion in vegetable acids, e. g. sour gruel (impure vinegar) and the juice of certain acid plants.

* * * *

Here ends Chapter Second of *Rasaratnākara* by Nāgārjuna on the *killing* of diamond and the metals, extraction of the essence of minerals and liquefaction of mica.

CHAPTER III.

I shall now explain [the process of] fixation of mercury. The king of rasas (mercury), rubbed with the juice of lime, sal-ammoniac, the acids, the alkalies, the 5 salts, *Piper nigrum*, *P. longum*, the dried root of ginger, the juice of *Moringa pter.*, the tuber of *Amorphophallus campanulatus*, can readily amalgamate itself with the 8 metals. 1

Prajñāpāramitā (perfection of wisdom) appeared before Nāgārjuna at midnight in a dream and revealed to him the ingredients of a recipe (consisting of steel, copper, mica, pyrites, &c.) 4

Mercury is to be rubbed with its equal weight of gold and then [the amalgam] further admixed with

sulphur, borax &c. The mixture is then to be transferred to a crucible and its lid put on and then submitted to gentle roasting. By partaking of this elixir (*i.e.* the sublimate) the devotee acquires a body not liable to decay. 30-32

I shall now describe the Garbha yantram.*
62-65

Recipe for Kajjali or aethiops mineral.† § 4-86

* * * *

Having made salutation to all the Buddhas, free from the taint of sins, I shall now deliver the Kakshapuṭa tantra ‡ for the benefit of suffering humanity.

[The most important part, from an historical point of view, is the dialogue between Nāgārjuna, King Sālivāhana and Ratnaghosha.]

Nāgārjuna, whose end (salvation) had been attained, benevolent towards all living creatures, blessed with all favours, residing on mount Srīsaila, before him stood Ratnaghosha with folded arms,

* The same as in Rasārnava. *Vide* Vol. i, p. 66.

† The process is practically the same as in Chakrapāni; *vide* Vol. i, p. 58.

‡ There is extant a Tantra, which goes by this name, the reputed author of which is Nāgārjuna.

saying : "Be pleased to communicate to me knowledge on chemical operations."

Nāgārjuna said :—

Well done ! well done ! I am pleased with your devotion and shall convey to you all that you want to know, namely remedies for warding off wrinkles, grey hair and other signs of old age. Mineral preparations act with equal efficacy on the metals as on the body (human system). *

* * * *

For the benefit of living beings I went through all manner of penances for 12 tedious years and worshipped the goddess Yakshinī presiding over the *Ficus religiosa*. Then I heard an oracle.

Nāgārjuna said :—

O Goddess ! if thou art propitiated, be pleased to communicate to me the rare knowledge of the fixation of mercury.

* * * *

Sālivāhana said :—

I have dedicated to thee, O Goddess ! treasures of gold and gems, now I await thy instructions.

* This was a favourite metaphor with the alchemists. Cf. Vol. i, Intro. lxxvi.

The Goddess said :—

Well done ! well done ! O wise ruler ! I shall speak to you of chemical operations performed by Māndavya.* A disciple should be intelligent, devoted to work, sinless, and master of his passions. †

The apparatus known as *koshthi*, mouth blow-pipe, cow-dung, substantial wood (as fuel), a pair of bellows, iron plates, * * * having collected all these, chemical operations are to be performed. ‡

* * * * *

Ratnaghosha said :—

Having prepared with great care “the powder of projection,” which transforms a ten million times its weight of the base metal into gold, § * * *

Nāgārjuna said :—

I shall convey to you what has been experimented upon by Sākānda. ¶

* A well-known alchemist ; one of the 27 adepts mentioned in the opening lines of R. R. S. *Vide* Vol. i, p. 77.

† Cf. “Initiation into discipleship” in Vol. i, p. 115.

‡ Cf. *Rasārnava* in Vol. i, pp. 64-65.

§ कोटिवेषी महारसः—the term वेषः has technical meaning. Cf. Vol. i, p. 120.

¶ We are unfamiliar with this name, probably the reading is corrupt.

Tests for killed mercury.

The first two couplets are almost the same as in Rasārnava. Cf. Vol. i, p. 74.

When the quicksilver, which has acquired the colour and the lustre of the rising sun, stands the test of fire (*i. e.* is not readily volatilised), then it is to be regarded as *fixed*.

Here follows a list of apparatus borrowed from Rasendramangala—Detailed account of most of these will be found in R. R. S. Bk. ix. *Vide* Vol. i, p. 67.

Chemistry in Rasahridaya of Bhikshu Govinda.

Quicksilver digested with sour gruel and then subjected to distillation is freed from [the impurities of] lead and tin. 1

Much the same as above. 2 * * * *

Description of the apparatus for purification of mercury by sublimation and distillation : it agrees almost literally with that given in R. R. S. Bk. ix, 6 8. *Vide* Vol. i, p. 121.

Patala vii.

Ingredients for making a *vida* for killing metals. Cf. *Rasārnava*, IX, 2-3. *Vide* Vol. i, p. 72.

Preparation of mild alkali from the ashes of plants :—

The process must be considered as a poor one, compared to the elaborate description in *Susruta*. Cf. Vol. i, p. 32.

Patala viii.

* * * Alum, blue vitriol :— all these severally or collectively are favourable for imparting colour to quicksilver. *

Experts [on the properties] of metals are of opinion that tin gives strength, *tikshna* colour, lead unctuousness, copper all these qualities [to mercury.]

Couplets (in p. 29, Sans. texts) : The purport seems to be that mercury is rubbed with certain sulphides, e. g. orpiment, pyrites &c., and sub-

* The text is not very intelligible. The other ingredients mentioned are *tikshna* and *kānta*, these being varieties of iron ; but iron will not amalgamate with mercury. *Tikshna* may also mean a kind of saline earth. The old alchemists racked their brains in devising ingenious processes for robbing mercury of its fluidity and imparting to it various colours Cf. *Rasārnava*, IX, 2-3, XI, 197-198. *Vide* Vol. i, p. 74 and also "The Hindu method of manufacturing calomel." —*Ibid.* p. 250.

limed, it assumes the colour of lac or *Coccinella* insect (a poetical and figurative way of expression for red colour) in the shape of the red crystalline sulphide.

Patala ix.

Vaikrānta, kānta, sasyaka, mākshika, vimala, adri, darada, rasaka :—these are the 8 rasas* and their essences are well suited for chemical operations.

Sulphur, gairika, kshiti, khechara (mica), aūjana, kankushtha :—these are the uparasa. Cf. Vol. i, p. 89.

Gold and silver are the *noble* metals.

Copper, brass, tīkshna and kānta (varieties of iron) are the essential or substantial metals ; lead and tin emit fœtid odours. Cf. Vol. i, p. 113, foot-note (1).

The six salts are :—Sauvarchala, saindhava, chūlika (sal-ammoniac), sāmudra, romaka and vīda. The alkalies are :—Sarjikākshāra, yavakshāra and borax. (*Vide* Vol. i, Index of subjects.)

Patala xi.

A cupel made of boneash (goat's) and lined internally with borax &c.

* Cf. Vol. i, pp. 79-81.

Colophon giving an account of the author :—

Madanaratha, King of Kirāta, teacher of mercurial lore, in whom the Goddess of the science of mercury and minerals (Chemistry), the source of all good, has taken her abode for the benefit of mankind, who can restore to the disfigured patient, afflicted with leprosy, the healthy comeliness and lustre of youth :

Bhikshu Govinda, well versed in chemical operations and loaded with honours by the King of Kirāta, composed this tantra entitled “Rasahridaya.”

This tantra is written by Govinda, the grandson of Maṅgalavishnu and son of Sumanovishnu :— May Tathāgata pronounce his blessings.

Chemistry in Kākachandesvari-mata Tantra.

Patala i.

The first patala gives the origin (mythical) of the tantra.

Patala ii.

Kākachandesvari said :—

* * * Please, give a brief account of the

Chemistry of the metals, the killing of mercury and minerals and the fusion of the gems. 3 4

Sri Bhairava said :—

* * * Mercury rubbed with the ingredients of the *vida* (see Vol. i, p. 72) and roasted in a closed crucible, is killed instantly. That mercury now acquires the power of converting a base metal into 1,000 times its weight of gold. 13-16

Copper, treated with the above preparation of mercury and rubbed with the acids, alkalies and the milky juice of *Calotropis gig.*, and roasted in a crucible, turns into gold. 18-20

Earth for making crucibles. 21-22 Cf. Vol. i, pp. 67-68.

Transmutation of iron into gold :—process not clear. 25-32

Patala iii.

Liquefaction of mica :—

Thin plates of mica are to be smeared with the 3 alkalies and borax and strongly heated in a crucible. The whole mass fuses.* * * * 29-30

* Refractory silicates are treated similarly at the present day with the "fusion mixture."

**Chemistry in Rasendrachudamani
of Somadeva.**

Sans. texts, p. 51.

Tests for killed iron (rouge).

As R. R. S. has borrowed these from the present work, it is unnecessary to repeat them here. *Vide Vol. i, pp. 118-119.*

Sans. texts, pp. 52-53.

Take lead of the weight of 30 palas and rub it with the milky juice of *Calotropis gig.* and calcine it till its weight is reduced to a karsha: this residue, even if it be calcined a thousand times, will not undergo further decay (*i.e.* diminution in weight). Metallurgists call this residue derived from lead Chapala.*

Tin also similarly treated will yield a chapala, which, on merely being touched with the hand, kills (fixes) mercury. This mercury is recommended for metallurgical and not for chemical purposes.

* Possibly it refers to lead derived from *argentiferous galena*. The lead, being cupelled off in the shape of litharge, will leave a button of silver, which will not undergo oxidation.

Sans. texts, pp. 53- 4.

[A somewhat complex process described, which is not very clear. We shall try to give the purport thereof. The quantitative measurements are of particular interest.]

1 pala of tin should be taken and rubbed with 10 nishkas of mercury and made into a cake with the addition of zinc ;* it is then to be digested with the decoction of certain herbs and plants and warm vinegar and once more rubbed with $\frac{1}{2}$ pala of blue vitriol † and the juice of *Abrus precatorius*. The mass is then to be divided into small pills ; these should then be put into a crucible with the lid on and the fire to be urged by means of bellows. The essence is then to be taken out of the crucible. This essence of the weight of 10 *Sānas* is then to be enclosed in a mixture of ashes and salts and roasted. This essence of the weight of 2 nishkas is then to be fused with 80 times its weight of lead * * * This (essence) is also termed chapala. Cf. "the gold-like alloy" in Vol. i, pp. 74 75.

* रसकाल सखेन.

† पलाङ्गुड़ सखेन.

Sans. texts, p. 55.

When quicksilver has been deprived of its physical properties (lustre, fluidity &c.) it is known as *nashtapishta*. Cf. Vol i, p. 74.

Somadeva will now give a brief account of the apparatuses, after having consulted numerous chemical tantras. (Here follows the description, which has been reproduced *verbatim* in R. R. S. *Vide* Vol. i, pp. 121 *et seq.*)

* * * *

Urddhvapātana apparatus as describod by Nandin. Cf. Vol. i, pp. 124-125.

Koshīkī apparatus as described by Nandin. Cf. Vol. i, p. 69.

Chemistry in Rasaprakasa-sudhakara of Yasodhara.

Sans. texts, p. 57.

Preparation of *karpūrarasa* (lit. camphor of mercury, *i. e.* calomel) : practically the same process as given in Vol. i, pp. 250-51.

[Note. Calomel is prescribed here only as an aphrodisiac and a specific for leprosy but not as a remedy for syphilis.]

Sans. texts, pp 59-61.

Rasaka (calamine) : the author of R. R. S. has evidently borrowed his description of this mineral from the present work. Cf. Vol. i, p. 87.

Extraction of zinc from calamine :

(The process agrees almost word for word with what is given in R. R. S. The essence possessing the lustre of lead runs out of the crucible.*)

Sans. texts, pp. 61-62.

Saurāshṭī or tuvarī (alum-earth) almost identical with R. R. S. Cf. Vol. i, p. 91.

* * * The essence extracted from the alums (*i. e.* oil of vitriol) is to be used for operations with metals and not as medicine.

Sans. texts, pp. 62-65.

[Descriptions of various kinds of pits for calcining and roasting purposes are given ; as also their dimensions with the number of cowdung-cakes to be used as fuel &c. Cf. the typical roasting pit in Vol. i, p. 127.]

* * * *

Here ends Chapter X of Rasaprakāśasudhākara by Yasodhara, son of Padmanābha.

* In R. R. S. we have "the essence possessing the lustre of tin."

Sans. texts, pp. 65-66.

Hemakriā or process for the fabrication of gold : "I shall now speak of some curiosities of metals, partly from my own experience and partly from the classics on the subject. Calamine, cinnabar, copper pyrites and realgar are to be rubbed with the milky juice of *Euphorbia neriifolia* for 7 days together and then to be digested another 3 days. Melted copper or silver or lead, being alloyed with the aforesaid mixture, acquires the power of converting 100 times its weight of base metal into gold."* Cf. *ante*, p. 2.

Chemistry in Rasachintamani Of Madanantadeva.

Sans. texts, p. 68.

Svetabhasma : Cf. *ante* p. 16 and also Vol. i, pp. 250-51.

Sans. texts, pp. 69-70.

Two processes for the fabrication of gold :—
much the same as already quoted from Yasodhara.

Process for the fabrication of silver :—

Take 1 part of bell-metal, 2 parts of silver, 4 parts of steel (?) * * these to be fused with

* शतवेषी and सहस्रवेषी are technical terms ; for the meaning of वेष *vide* Vol. i, p. 120.

tin and borax ;—by this process will be made silver which will pass current for commercial purposes.

Sans. texts, p. 71.

Extraction of zinc from calamine :—

The process is much the same as given above (p. 17), whith this difference that, whereas Yaso-dhara hits off the completion of reduction when the flame issuing from the pot ceases to be blue, the present author directs that the pot is to be taken out of the furnace as soon as white fumes begin to appear. The crucible is then to be held in an inclined position so that the lead-like essence of calamine drops on the ground.

Chemistry in Rasakalpa (Rudra-yamala Tantra.)

Bowing to Siva, the lord of mercury, and also the feet of Chandikā, I write this Rasakalpa, the depository of mercurial lore.

CHAPTER 1.

Tests for *killed* mercury :—

Killed mercury is that which is devoid of (metallic) lustre, not so ponderous, white,* des-

* The author previously refers to the red, black, white and even yellow ash (calx) of mercury ; it is not clear why he should

troyer of metals, divested of fluidity and non-volatile when stirred over a fire. 40 Cf. tests in *Rasārnava* in Vol. i, p. 74 ; as also in *Rasaratnākara*, *ante*, p. 9.

Purified mercury should be preserved in the hollow of a tooth or gem or bamboo. 42

CHAPTER II.

Gold, silver, copper, tin, lead and iron—these are the 6 metals ; vartaloha, &c., (Vol. i, p. 114) are simply alloys. 1

Honest readers ! I beseech you with folded arms to favour my book with your merciful glance.

The mahārasas are 8 in number ; e. g. mercury, cinnabar, sasyaka, rasaka, &c. the rasas are mica, green vitriol and rājāvarta, &c. sulphur, orpiment and realgar, &c. are the uparasas as regarded by learned teachers. Cf. Vol. i, pp. 79 and 89.

There are 4 kinds of sulphur :—white, black, yellow and red. Cf. Vol. i, p. 90.

* * * *

here restrict himself to the white variety only. Chloride or sulphide of mercury, when treated with a metal and heated, kills (i. e. parts with its chlorine or sulphur to) the latter and in that sense it is a destroyer of metals विद्धा।

The saurāshtris (alums) are of various kinds ; the kāsīsas (vitriols) are of 3 kinds,—namely, kāsīsa proper, pushpa kāsīsa and hīrakāsīsa.* Cf. Vol. i, p. 91.

Gairika is stated to be of 2 varieties,—the one of golden hue, the other red ; Kaṅkushtha and other rasas are also described by certain teachers ; but these, however, are not referred to here, as we are treading in the footsteps of sages of old.†

Sans. texts, pp. 75-78

For the purification of mercury this process is recommended by Svachchhandabhairava and Govinda.

Chūlikalavana (Sal-ammoniac), sulphur and the ash of ginger, &c., digested one hundred times with cow's urine,.....make a *vida* for killing gold. Cf. Vol. i, p. 72.

This process for killing [metals] was revealed by Siva and has been transmitted by successive schools of adepts.

* Hīrakasa is the name by which green vitriol is known throughout India; Royle supposes that this word is derived from the Persian *hura* green, and Sans. kāsīsa, (Antiq. Hindu Med.) There is no necessity for looking upon hīrakasa as a hybrid term, seeing that it occurs in the present work in which Mahomedan influence is nowhere traceable.

† Evidently Charaka and Susruta, who mention only a few commonly occurring minerals. *Vide* Vol. i, pp. 29 and 44.

Extraction of the essence of copper pyrites. Cf. Vol. i, pp. 70 and 84.

Extraction of zinc from calamine :—

The process is practically the same as given in R. R. S. Cf. Vol. i, pp. 87 88.

I have performed the [aforesaid] experiments with my own hands and have seen them with my own eyes. They are not recorded from mere hearsay or from the dictation of a teacher. These are being promulgated for the benefit of mankind.

Chemistry in Rasarajalakshmi of Vishnudeva.

Sans. texts, pp. 79-82.

Give an account of the common rasas and uparasas. Cf. Vol. i, p. 79.

Chemistry in Rasanakshatramalika of Mathanasimha, physician to the King of Malwa.

There are several prescriptions given in which mineral preparations play a conspicuous part. We have quoted only two ; in the first, among other ingredients opium occurs ; in the second, 'the

Svachchhandabbairavarasa, probably named after the celebrated alchemist, we have the *calces* of tin, iron and mercury along with other drugs.

Chemistry in Rasaratnakara of Nityanatha.

Sans. texts, pp. 84-86.

Test for killed mercury :—

When the substance, being heated over a fire of paddy husks, does not further decrease in weight, it should be considered as reduced to a calx.

Purified mercury should be stored in the hollow of a tooth or horn or bamboo.

Directions for making factitious cinnabar (Makaradhvaja). Cf. Vol. i, p. 132 (footnote).

Chemistry in Dhaturatnamala.

In the beginning the author after salutation says : ‘I shall speak of silver, gold, copper, lead, tin and iron as also of calamine, mica, pearls, coral, ~~orpiment~~, realgar, the pyrites, mercury and diamond,— in fact, the properties of all the metals and minerals and the mode of their incineration.’

Killing of silver. Cf. Vol. i, p. 107.

Chemistry in Rasapradipa.

Description for preparing mineral acids by distillation :—“*Sankhadrāvaraṣa* or liquid for dissolving conchshells,—practically the same as given under “mineral acids” in Vol. i, p. 186. The last line says: “Cowrie-shells and metals dropped into the liquid are at once dissolved.”

Preparation of calomel and treatment of “phirangi-garoga” (syphilis) with its application. Cf. Vol. i, p. 252.

Chemistry in Dhatukriya or Dhatumanjari (Rudrayamala-tantra.)

Sans. texts, pp. 98 et seq.

Tin, iron and copper are to be classed among the superior metals.

In general a metal being alloyed with silver is improved in quality. Sattvaja metal (*i.e.* an alloy of tin and copper, *vide* below couplet 15) is of middle quality. 12-14

Synonyms of the different metals. 39-49

Synonyms of zinc: Jāsatva, Yasadāyaka,* rūpyabhrātā (lit. brother to silver), charmaka, kharpara, rasaka, &c. 50-51

* Yasada is the name commonly given to the metal extracted from calamine, *Vide* Vol. i, p. 156

Pittala is an alloy of copper and zinc. 63

Kāmsyal is an alloy of tin and copper. 65

Zinc being amalgamated with mercury gives rise to rasaka. 68

[*N.B.*—Rasaka and kharpara are the names generally applied to the mineral calamine (*vide* Vol. i, p. 158), but here they stand for the metal (zinc) or its amalgam.]

Lead being killed with the aid of gentle heat gives rise to minium (red lead). 69

Copper in combination with the “burning water” gives rise to tuttha (green vitriol).—Thus manifold operations are performed with the aid of *mantras* and apparatus : all these belong to the province of Chemistry. 70·71

Synonyms of haritāla (orpiment) : Orpiment is a consumer of mercury and also a clipper of its wings.* 79

Synonyms of realgar, cinnabar, mica, &c. 81-89

Synonyms of pearls, coral, tortoise-shell, conch-

* The sulphide of arsenic on being rubbed with mercury and gently heated converts the latter itself into the sulphide. The mercury is thereby *killed* and *fixed* i.e. deprived of its volatility (clipped of its wings—the Hindu alchemist's favourite figure).

shell, tusk of elephants, the tail of the peacock.
90-I08

Localities for different metals. 113-121

[The information is very commonplace.]

Localities for copper specified : Nepāl, Kāma-rūpa (the eastern portion of Assam), Bangala, † the country of the Mlechchhas, Rūma and the country of the Phirangas, &c. 143-145

Localities for zinc : Kāmboja, Rūma, Balkh, &c.
146

Metals in combination with mercury and sulphur become fit for administration as medicine. 153

* * * *

Process of roasting a substance in a stout glass-vessel using goat-and-cow-dung-cakes and husks of paddy grains as fuel. 9 10

One part of gold and four parts of zinc are to be melted together and the alloy roasted in a closed crucible . . . the process repeated with the addition of alkalies . . . gold of a reddish yellow colour will thus be generated. 11-17

* All these have been placed under the category of (हीन) inferior dhātu. Though the term dhātu generally means a metal, it is often applied to a mineral ; here, however, it covers a much wider field.

† This is the name given to Bengal in many Tantras.

A process for making factitious cinnabar by pouring mercury into its own weight of molten sulphur and then adding three-fourths its weight of orpiment . , . . The mass to be rubbed in a mortar and subjected to sublimation. 23-30

By using the *augmented** gold as a means of exchange one can amass wealth. 52

Tin is to be melted and one-hundredth part its weight of mercury to be amalgamated with it. This [fraudulent substitute for] silver can be used for purposes of exchange, and one can thus amass wealth. 85-86

Pure gold is to be alloyed with one hundred times its weight of copper and this [imitation] gold will resemble native gold. 88

Lead and copper being alloyed together will give rise to gold. 97-98

Colophon : Here ends the Chapter on the extolling of gold in Rudra-yāmala.

* Cf. footnote, p. 2.

shell, tusk of elephants, the tail of the peacock.
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* Cf. footnote, p. 2.

Chemistry in Suvarnatantra or Svarnatantra.

The origin of the tantra is explained in the opening lines. Parasurāma having given away his worldly possessions to Kasyapa is rendered destitute, and thus has to invoke the aid of the God Siva for his very maintenance.

Siva said : Listen ! I shall now reveal to you the most wonderful mysteries of Svarnatantra. 1-10

A kind of oil is exuded from the bulbous root of a plant ; all around it within a radius of ten cubits oily water is exuded and a venomous snake lives under it. If you want to test the properties of the bulb, you should thrust a needle into it, and the needle at once dissolves. Having procured this bulb, rub it with mercury in a mortar and add the oil and subject the mixture to heat in a crucible. The mercury is at once *killed* and acquires the property of converting one hundred thousand times its own weight of the base metal into gold.* 14-18

Pure orpiment is to be rubbed with this oil for 20 days, and the former is killed thereby and loses its volatility. The 8 metals in the molten state being treated with this prepared orpiment acquire

* सर्ववृत्ती भवेत्.

the power of transmutation. When the above oil is thrown into molten copper, it is turned into gold of beautiful lustre. Tin and bell-metal similarly treated are turned into silver, and copper, iron, brass and silver into gold. 19-24.

Saṅkhadrāvaka (*aqua regia*, see *ante p. 24*) is spoken of as an universal solvent This solvent with mercury is to be placed in a glazed crucible and subjected to heat; the mercury, thus *killed*, can convert the 8 metals into gold. By partaking of this mercury one becomes immortal; even his urine and fæces can convert copper into gold.* 1-10

* This sort of belief was prevalent also at the time of the composition of *Rasārṇava*.

Knowledge of Gems.

A few words on gems may not be considered beyond the scope of the present work especially as the subject has already drawn the attention of some European scholars.* We shall, however, limit ourselves, as far as possible, purely to the physical and chemical properties of the precious stones.

It has already been seen that among the 64 branches of arts and sciences recognised in the ancient 'Kāmasūtra' of Vātsyāyana occur the following :—(a) the testing [of the genuineness or otherwise] of gold and the gems ; (b) knowledge of the colouring of gems, as also of mines and quarries.† Varāhamihira (d. 587 A. D.) in his "Vṛihat Samhitā" also conveys much useful information on this subject, but as he in his turn refers

* Garbe in his "Indischen Mineralien" (Leipzig, 1882) gives the text and the translation of Ch. xiii of Narahari's "Rājani-ghantu" ; this work, however, is comparatively modern. Much useful information on the subject with bibliographical references will be found in Professor Yogesa Chandra Rāy's treatise in Bengali entitled "Ratnaparikshā."

† *Vide* Vol. i, p. 191.

to experts who preceded him,* it may safely be concluded that long before this time it received adequate attention.

The *Garudapurāna* under the heading of *Ratnaparīkshā* (examination of the gems) devotes several chapters to a detailed and fairly exhaustive description of the gems. This *Purāna* like so many of its class discusses on a variety of topics, mundane and spiritual ; in short, it may be looked upon as a sort of *multum in parvo*.

From time immemorial the gems have been valued in India not only for purely decorative and ornamental purposes, but also as agents for warding off perils and the malignant influences of the planets and for securing luck and longevity. Hence it is that particular attention is paid to the testing of gems, as their virtue increases in proportion as they are faultless and flawless.

The typical characters which were most relied upon for differentiating one species of a gem from another were (1) the relative weight, (2) hardness, (3) lustre, transparency and colour, (4) fusibility, especially when heated in combination with the alkalies. It will be noticed that even the lapidaries

* पूर्णाचार्यः उमुहितः

and the mineralogists of the present day have to depend largely upon these properties in the classification of the *stones*. We shall now proceed to say a few words under each of the above characters following in the main the authority of *Garudapurāna*.

1. RELATIVE WEIGHT. We have purposely used these terms as contradistinguished from "specific gravity": as the latter connotes peculiar associations. The principle of Archimedes being evidently unknown among the Hindus, the measurement of volume could only be roughly approximate. To cite some illustrations. A stone may be of the same species as, and equal in volume to, a padmārāga (oriental ruby), but will differ in weight from the latter.*

Empirical and arbitrary scales of weight were adopted as standards. A ruby occupying the volume of a guñja (*abrus precatorius*) may be equal in weight to 10.7 and 3 guñjas respectively. A ruby of the volume of a *srigālakola* (a kind of jujube) should weigh 12, 8 and 7 guñjas respectively. Again, a ruby of the volume of an āmalakī (*phyllanthus emblica*) should weigh 30.20

* तुस्यप्रमाणम् च तुस्यकातेऽयौ वा शुद्धतेन भवेत् तुस्यः।

and 16 māshās respectively.* In each case the gem which is of greater weight is superior in quality and the value thereof is enhanced in proportion.†

In the case of precious metals, however, adulteration was detected by an ingenious device, which may be regarded as a near approach to the principle of Archimedes. Suppose it is intended to test the purity of a specimen of gold. All that one has to do is to draw a wire of this gold and another of the standard gold through the self-same orifice [of corundum]. As these wires are of equal

* We give below the standard weights as current at the time of Varāhamihira.

8	White mustards	...	=	1 tandula (a grain of paddy)
4	Tandulas	...	=	1 gunja (<i>abrus precatorius</i>)
5	Gunjas	..	=	1 Māshá
16	Māshás	..	=	1 Karsha or suvarna or tolaka
4	Karshas	...	=	1 pala

The standard of weight has always varied in different times in different parts of India. 10 gunjas weigh about 18 grains. The seeds often vary in size.

† Garuda lays special stress on the high specific gravity (= 4·0) of a genuine ruby. लघुल विक्षीतिलिङ्, again युक्त भवोन् युषसंयहः। While high specific gravity is indicative of the excellence of the gems in general, in the case of diamond it is just the reverse. युक्ता सर्वरकान् गौरवाधानकारणम् । वज्रं तत् वैपरीतेन सूर्यः परिचक्षते ॥ It is not easy to account for this qualifying clause, seeing that diamond has a sp. gr. of 3·5.

diameters, equal lengths will have equal weights, provided the sample is pure.*

2. HARDNESS. There are many stones which in external appearance resemble a ruby ; the spurious substitute may easily be detected by its difference in softness (low degree of hardness), and low specific gravity : again in case of suspicion the gem is to be rubbed on a whetstone ; if it simply gains in lustre but does not lose in weight (by abrasion), the specimen is to be regarded as genuine (test of a ruby).† Diamond and corundum alone will scratch ruby and sapphire. Skilful lapidaries often make imitation diamonds of zircon, ruby, cat's-eye, rock-crystal and glass ; hence they are to be tested by calling in the aid of learned experts. All the gems occurring in this world as also the metals will be scratched by a diamond, but the latter will not be similarly affected by the former.A diamond alone will scratch a diamond.‡

* एकचाहे समान्तर समख्ये हयोऽयंदा ।

धात्वा: सूर्यं मानसम् गिर्दुटस्य भवेत्तदा ॥ Sukrānti.

† This is true in a qualified sense only. After the diamond corundum is the hardest of all known minerals.

‡ The ruby and the sapphire are only varieties of corundum. Varāha classes corundum as a species of ruby, the former being dotted over with black and white patches and feeble in lustre [i.e. the non-transparent or course kind]. It is scarcely necessary to

To the above tests Rājanighantu adds another, namely, when a diamond is struck with an iron hammer, it is not broken to pieces*

point out that the very word "corundum" is derived from the Hindi *kurand*, a corrupt form of the Sanskrit *kuruvinda*. The statement "corundum will scratch ruby and sapphire" is not strictly accurate. There are degrees of hardness among the different varieties of corundum, the blue sapphire standing first in this respect.

We give here the original texts of which we have given above almost a literal translation.

"ब्रह्मभेदो यदुता लघुतं विजातिलिङ् खलु सार्वजन्यम् ।"
 "अपश्चस्ति सन्देहे शिखायाऽपरिवर्द्धयेत् ।
 शृणु योऽच्यत्तोभावान् परिमाणं न मुच्चति ।
 स चेयः गुह्यातिस्तु ज्ञेयाद्याच्ये विजातयः ॥"
 "वलुं वा कुरुविन्दं वा विमुच्यान्वेन कीरचित् ।
 न शक्यं संख्यनं कर्तुं पश्चारागेन्द्रनौलयोः ॥"

* The reading of the text is very corrupt. Garbe gives as many as 12 variants ; that adopted by him seems to be on the whole reliable as also his rendering : "Wenn er mit anderen steinen oder eisernen Hämtern geschlagen nicht zerspringt." On account of its brittleness a diamond will readily be shivered into splinters under the blow of a hammer. The following extract from Bauer and Spencer's "Precious stones" (pp. 129-130) may prove of interest.—

"The hardness of diamond has often been confused with its frangibility or brittleness. It has been supposed, especially in ancient and mediaeval times that hammer and anvil may be shattered but not the diamond which lies between.

3. LUSTRE, TRANSPARENCY, COLOUR and other optical properties. Difference in lustre (लेहमिद) is often regarded as a diagnostic feature of the gems. According to Varāha gems of superior qualities should possess cool (lit. waxy) lustre, be limpid and emit rich rays. Classification according to colour is often enjoined. For instance, a diamond may be perfectly colourless, or it may be yellow,

This statement was made by Pliny, the great naturalist of ancient days, who was killed in 79 A.D. at the first historic eruption of Vesuvius. He proceeded to say further that the fragmentation of a diamond may be effected by subjecting it to a preliminary immersion in the warm blood of a goat, but that even under these circumstances the hammer and anvil will also be broken ! According to Albertus Magnus (1205-1280) the blood is more efficacious if the goat has previously drunk wine or eaten parsely.

"Such being the views then held respecting the unbreakable and indestructible character of the diamond, it is easy to understand why the Greek word *adamas*, signifying unconquerable, should have been applied to this stone, although its application to the diamond is singularly inappropriate and inaccurate when its extreme frangibility is considered. Many a doubtful stone has been submitted to the test of the hammer, with the belief that the blow would be resisted only if the stone were a genuine diamond. Probably many beautiful stones have been sacrificed to this old belief. As a matter of fact, diamond is easily fractured, a very moderate blow from a hammer sufficing for the purpose ; its perfect cleavage places it among the most brittle of minerals."

black, red or copper-tinted.* Stones which are translucent, opaque and of dull colour are inferior in quality. In the case of diamond special stress is laid on its displaying the colours of the rainbow [due to its high dispersive power]. Some gems have only one shade of colour (एकचाय) others again two (द्विचाय)†

The changes in colour which the ruby and the sapphire undergo under the influence of heat had evidently been carefully observed. This test is to be applied with extreme caution as in case the pro-

रक्तं पीतं सितं ग्रेरोषं (Varāha) गःताम् (Garuda).

Yellow diamonds are unknown in India at the present day at any rate. "India can claim for its own all the finely coloured stones of blue, green and red, not however, yellow diamonds, which come mainly from South Africa." (Bauer and Spencer). Crystals of black diamond should not be confounded with the black carbonado.

+ Probably refers to dichroism. As has already been pointed out the red ruby and the blue sapphire are only varieties of corundum, which often occur in well-developed crystals belonging to the rhombohedral division of the hexagonal system. "The dichroism of the ruby affords a means whereby it may be distinguished with certainty from other red stones, such as spinel and the different varieties of garnet, which crystallise in the cubic system, and thus being singly refracting can show no dichroism." (Bauer and Spencer). "The dichroism of the sapphires of Siam is specially well marked."—*Ibid.*

per degree of temperature अधिकतमा ये is exceeded, the stone may be materially injured.*

4. FUSIBILITY (LIQUEFACTION). It was well-known that all the gems with the exception of diamond would undergo liquefaction when strongly heated with a mixture of the two alkaline carbonates [now familiar in the Laboratory as the "fusion mixture"]. The liquid principle of gems रबजा द्रुति was a favourite remedy with the Hindu Iatro-Chemists (Cf. Vol. i, p 103). As most of the precious stones belong to the corundum and the spinel group, they easily yield to treatment with sodium and potassium carbonates. In the case of the pearls it is recommended that they should be enclosed inside lemons and placed in a mass of paddy grains [for the sake of the warmth].

* यावनं चक्रमेदप्ति पश्चरागोपधीगतः (१) ।

इन्द्रगोलमसिद्धात् क्रमेत सुमहतरम् ॥

सशाप्य न परोक्षाधैर्गुणानामभिहृष्ये ।

मधिरस्यौ समाधेयः कथचिद्दपि कश्चन ॥

अधिमात्रा(१)परज्ञाने दाहदीष्यै दूषितः ।

सोऽनर्थय भवेद्भर्तुः कर्तुः कारयितुक्तया ॥ Garuda.

Cf. "The red ruby, at a high temperature, is colourless : on cooling it first becomes green, after which it gradually assumes its original fine red colour." (Bauer and Spencer). "The blue colour of the sapphire disappears on heating."—*Ibid.*

GENERAL AND CONCLUDING REMARKS.

The crystalline character of the minerals is referred to in one or two places. All the old writers agree in describing the diamond as having 6 angles. 8 faces and 12 edges.* The octahedral form of the crystal is common in the diamond occurring in the neighbourhood of Panna in Bundel Khand. Rājanighantu further adds that the stone is often endowed with numerous faces and edges.† According to Rasaratnasamuchchaya the female diamond is flattened and rounded whilst the neuter is rounded and obtuse-angled ‡ Vaikrānta is also

* कोव्यः पार्वनि धारास चक्रौ इदंश्चेति । Garuda.

† "In most cubes of diamond, however, each edge is replaced by two faces,.....the twenty-four faces thus derived would, if produced or enlarged" sufficiently, give rise to the form known as the four-faced cube, or tetrakis-hexahedron. (Bauer and Spencer).

‡ The rendering of the description of diamond in R.R.S. (*vide* Vol. i, p. 100) is based upon a misreading. The correct reading is that adopted by the Poona edition, namely, चक्रास चाषफलकं चट्काणं "a diamond has 8 faces and 6 angles." The author evidently uses चक्र and फलक in the same sense ; there cannot be any confusion here, as distinct mention is made of the 6 angles. As a rule चक्र and कोण are used synonymously. Thus in Varāha चक्र is described as चक्रस्ति ; the commentator Bhaffotpala explains it चक्रमिरचिभिर्युक्तं चट्कोणमित्यर्थः । "Rounded" (वर्त्तल) : Cf. Bauer and Spencer. "The faces of diamond crystals differ from those of most other crystallised minerals, in that they are as a

(probably a mineral of the spinel group. *vide* Vol. i, p. 83) described as having 8 faces and 6 angles.

It is sometimes asserted that the phosphorescence of diamond was first observed in 1663 A. D. by the celebrated Robert Boyle. Bhoja (11th century A.D.), however, mentions this property.* Faults in precious stones due to isolated grains of minute gravels etc., embedded in the mass [now technically called "enclosures"], are also referred to.†

It may be noted here that what is generally known as the Indian or Tavernier's rule for determining the value of diamond can be traced back to a remote date. *Sukranīti* speaks of it as the "rule of squares,"‡ while Varāha, himself a great rule, much curved and rounded instead of being perfectly plane as is usually the case." p. 119. "Obtuse-angled" (कुरुकोणाय) in the crystallographic terminology should be rendered as "with corners truncated off."

* अन्धकारे च दीप्त्यते (phosphoresces in the dark).

† कलुषा मन्दयुतयो खेखाकोणाः सधातवः खस्तः ।

दुर्विज्ञा न मनोज्ञाः सर्शकराश्वेति मणिदोषाः ॥ Baráha.

Here सधातवः and सर्शकराः no doubt refer of the minute pebbles (gravels) enclosed in the body of the stones.

‡ यथा गुरुतरं वज्रं तन्मुखं रक्तिवर्गंत; i. e. if a diamond weighing 1 *rati* be worth x, one of the weight of 4 *ratis* will be worth $2 \times x$.

mathematician, gives practically the same rule, though somewhat on an elaborate scale.*

It would be unfair to compare the progress made by the Hindus in this branch of knowledge in the 6th century A.D. and perhaps earlier with that of the present day. Reference to the crystalline forms of diamond can be found in the writings of Keppler, Steno and Robert Boyle in the seventeenth century. Scientific crystallography originated with Romé de l'Isle and the abbé Haüy at the end of the eighteenth century. The various physical and chemical properties of the minerals culled here bespeak considerable powers of keen observation.†

i. e. if a diamond weighing 20 tandulas (p. 33 *ante*) be worth 2 lacs (2,00,000), one weighing 5 tandulas will be worth only $(5^2 \times 4 = 100)$ th part of 2 lacs or 2,000.

† Concerning Ratnaprikshá cf. also "Les Lapidaires Indiens" by M. Finot in the "Bibliothèque de l' Ecole des Hautes Etudes."

**NOTE ON THE METHOD OF PREPARING
CAUSTIC ALKALI.**

In the first Volume of our History the detailed description of preparing caustic alkali from the ashes of plants has been quoted at length from the *Susruta* and we referred to it "as a proof of the high degree of perfection in scientific pharmacy achieved by the Hindus at an early age."* M. Berthelot has no less been struck with the originality of this process; indeed, he goes so far as to suggest that this portion in the *Susruta* is evidently modern and in fact a later addition derived from contact with the European chemists.†

The process of rendering mild alkali caustic by the addition of lime is to be found also in *Chakrapāni* (c. 1050 A. D.) and *Vāgbhata*, who must have preceded the former by several centuries, and it is well known that both these authors are deeply indebted to the *Susruta*. There is not thus the remotest chance of inspiration from the European chemists.

* *Vide* Vol. i, Intro. c.

† *Journal des Savants*, Jan. 1903, p. 42.

We have evidence from quite an unexpected and independent source that the cauterization of bad wounds by means of caustic alkali was an established custom in ancient India. Thus we read in "The Questions of king Milinda":—

"And when the inflammation had gone down, and the wound had become sweet, suppose he were then to cut into it with a lancet, and burn it with caustic. And when he had cauterized it, suppose he were to prescribe an alkaline wash Now tell me, O king ! would it be out of cruelty that the surgeon . . , . thus cut with the lancet and cauterized with the stick of caustic."*

* "Sacred Books of the East," Vol. XXXV, p. 168.

Although Milinda has been identified with the Bactrian Greek king Menander (c. 140—110 B. C.), it is not to be supposed that any Greek influence can be traced in it. In this ethical romance, king Milinda and the Buddhist Bhikshu Nágasena have been put forward simply "as men of straw" to quote Rhys Davids. The work in reality conveys the teachings of the older Buddhists (Hínayánists) with the background of Sámkhya and Vedánta metaphysics.

The Tantrists, the Rosicrucians and the seekers after truth.

The East has not been always East and the West, West. Modern Europe is materialistic, but she has not disdained in the past to "plunge in thought." This reminds us of the truth of the poet's words : "one touch of nature makes the whole world kin." Ancient Greece had her orphic mysteries. They were developed into a religious and ethical system by Pythagoras. In the schools of Alexandria the neo-Pythagoreans and the neo-Platonists further added to it the Vedantic doctrine of a world-soul.

"With the dissolution of the neo-Platonic school in the sixth century, Greek philosophy disappears, it is true, as distinct phenomenon from the theatre of history, but it continues to exist in combination with foreign elements in the service of a new form of culture in the Science of the Middle Ages and of modern times." (Zeller).

Says Waite :—

"The traditions of the new-Platonic philosophy, with its elaborate theurgical system, were to some extent perpetuated through the whole period of the Middle Ages, for besides the orthodox theology of the great Latin Church and amidst the clamour of scholastic philosophy, we find the secret theosophy of the magician, the Kabbalist, and the alchemical adept borrowing, directly or indirectly, from this prolific

fountain of exalted mysticism. The traces of its influence are discoverable in Augustine, in Albertus Magnus, in St. Thomas, the angel of the schools, and in other shining lights of western Christendom, while the metaphysical principles of Johannes Scotus Erigena, even so early as the close of the ninth century, were an actual revival of this philosophy."*

History repeats itself. In India the Yoga doctrines of Patañjali paved the way for the origin of Tāntric mysticism and it associated itself with magic and alchemy. Some twelve centuries later, this phase in the stage of human progress found exponents in the soil of Europe. As Waite says :—

"In an age of progress, of doubt, and of great intellectual activity, it is singular to remark the almost invariable prevalence of mysticism in one or other of its manifold phases, and the close of the sixteenth century beheld spreading over the whole of Germany and passing thence into Denmark, France, England and Italy, a mighty school of mysticism in the great multitude of magicians, alchemists, &c., who directly or indirectly were followers of the renowned Paracelsus."†

* "History of the Rosicrucians," p. 27. Regarding the sect of the Cabalists see also Lecky's "Rationalism in Europe." Vol. i, p. 42. ed., 1900.

† See also Kopp's "Die Alchemie in älterer u. neuer Zeit," ii, pp. 1—146, on the "Bekanntschaft mit Geheimnissen der Magie, Theosophie, Alchemie u. A."

Even the lower strata of society in England did not escape the contagion. Sir William Temple observes : "I have had several servants far gone in divinity, others in poetry, have known in the families of some friends, a keeper deep in the Rosicrucian mysteries."

There are those who sneer at the attempts of the alchemists to convert the baser metals into gold and are at the pains to insinuate that the motives of the adepts were sordid. It may be that there have been here and there men—vulgar charlatans—who have pursued the *art* merely from worldly considerations. The high priests of alchemy, however have in every age and clime been honest seekers after truth. Had there been no desire implanted in the human breast to pry into the hidden and occult mysteries of nature there would have been no science. Whence come we and whither are we destined to go ? What is this substance made up of, and what are its ultimate constituents, and what will its combination with this or that lead to ? These are queries, the solution of which or rather the very attempts to solve which mark the birth of philosophy. Patanjali and Nāgārjuna in India and Paracelsus in Europe stand forth as the prominent representatives of

this spirit of inquiry. They have been dreamers, mystics and naturalists all combined in one. Such geniuses have always chafed at the restraints and limitations imposed on frail man and hence their fervid yearnings to peep into regions beyond the ken of our gross senses. As Emerson puts it :—

"The privilege of this class is an access to the secrets and structure of nature, by some higher method than by experience. In common parlance, what one man is said to learn by experience, a man of extraordinary sagacity is said, without experience, to divine."*

Plotinus heaved a sigh at the soul with its infinite possibilities being caged in a frail and corruptible body. The pursuit of alchemy by the esoteric *Tantrist* is easily explained. To him it was only a means to an end. "It (mercury) is alone that can make the body undecaying and immortal."† We find echoes of the same sentiment in the authoritative literature of the Rosicrucians,

Says Waite :—

"Among the concourse of inquirers, and the clamour of supposed and pretended discoverers, there rose gradually into deserved prominence an advanced school of illuminati,

* "Swedenborg ; or, the mystic."

† *Vide "History of Hindu Chemistry," Vol. i. Intro.*
lxxvii and xcv—xvi.

who, employing the terminology of the *turba philosophorum*, under the pretence of alchemical pursuits appear to have concealed a more exalted aim. . . . The student is directed by these writers from the pursuit of material gold to the discovery of incorruptible and purely spiritual treasures. . . Physical transmutation, the one and supreme end of the practical alchemist, sinks into complete insignificance ; nevertheless, it is performed by the adept and is a landmark in his sublime progress." l. c. p. 32.

The sage and seer of Hoenheim had his wrestlings. Should he pursue knowledge for its own sake or for what it bringeth ? His evil genius holds out the bait thus :—

"Know not for knowing's sake
But to become a star to men for ever ;
Know for the gain it gets, the praise it brings,
The wonder it inspires, the love it breeds."*

The spiritual at last triumphs over the base in man. Paracelsus has his revelation, and he bursts forth :—

"Truth is within ourselves : it takes no rise
From outward things, whate'er you may believe,
There is an inmost centre in us all
Where truth abides in fullness : and around
Wall upon wall, the gross flesh hems it in,
The perfect clear perception—which is truth."*

* Browning's "Paracelsus."

In the above delineation the poet has done no more than bare justice to the inward longings of an ideal alchemist, who is only an honest seeker after truth. The spiritual and thought-world has always transgressed all barriers of time and space. Kanāda, Patañjali and Nāgārjuna of India and Heraclitus, Empedocles and Plato and the rest—they all form a holy fraternity ; aye, these prophets and oracles of the intellect belong to a “lofty and sequestered class,” “the high-priesthood of the principles of thought from age to age. When at long intervals we turn over their abstruse pages, wonderful seems, the calm and grand air of these few, these great spiritual lords, who have walked in the world,—these of the old religion,—dwelling in a worship which makes the sanctities of Christianity look *parvenues* and popular ; for ‘persuasion is in soul, but necessity is in intellect.’ ”*

* Emerson : on “Intellect.”





**The metals and their loss in weight
after calcination.**

Very vague ideas prevailed among the Hindu philosophers on the constitutions of a metal and its fate after calcination. We are reminded of the diversity of opinion in Europe before the time of Lavoisier. A metal like every material substance was supposed to be formed of one or more of the five, bhūtas ; in fact the earthy or saline element was taken to be predominant in it,* and hence it lent itself so readily to calcination. † It should be noted here that by "bhūta" was understood not so much an element in the modern connotation of the term as certain qualities of individual substances. Even mercury was regarded as composed of the five bhūtas. ‡ When a metal was submitted to calcination some of its component bhūtas escaped, leaving the earthy or saline portion behind ; hence the ash (calx) must weigh less than the original metal itself

* प्रधिवा: चुर्चरवत्तमविनुजामनःशिखाकृतपादादः । Ch. 1., 4. 2
 Again in Ch. XLVI (Sūtra) 345 et seq. the metals are included among the saline ingredients.

† Cf. "For some maintain that gold is solid light, or, at least that the chief ingredient is light, which is rendered solid by mixture with some particles of earth. Were it mere earth it might be calcined by fire strongly urged.—Vol. 1. P. 9.

‡ पचमूलाम इति इडलेय सहायिः । इवि रक्षार्थिः ।

There is, however, no direct reference to be met with anywhere as regards the quantitative aspect of the question so clearly established by Lavoisier.

The proportion of loss which a metal undergoes on ignition was made the basis for determining its purity and we find in the law-books an arbitrary scale fixed. Thus according to Yājñavalkya, "gold is unaffected by fire, while one hundred parts by weight of silver, tin and copper lose (lit. undergo decay to the extent of) two, eight and fifteen parts respectively.* This is to be taken as referring not to the roasting (killing) of a metal but simply as allowance made to goldsmiths and other artisans for loss incurred in the shape of dross &c. when it is melted in a crucible.

That copper, lead, tin and other base metals (होमधातुः) when repeatedly calcined are completely reduced to their calces was well known as will be seen throughout the body of the texts. The passage from Rasendra-chūdāmani (p. 14) deserves some notice. Lead of the weight of 30 *palas* is to be calcined till its weight is reduced to a *karsha* (= $\frac{1}{4}$ *pala*). Even if it be calcined now one thousand times, it will not undergo further reduction in weight. Our author evidently had his experience of lead derived from argentiferous galena, which would leave

* अस्मी सुवर्णमत्तीष्ठं हिपलं रक्षते शते ।

अस्मी व्रश्चिं-स्त्रीसे च ताम्बे पच्छदशायसि ॥

a residue in the shape of a "button" of silver after the lead had been cupelled off. *

* Similar confusion prevailed in Europe up till the end of the 17th century. The following extract from Robert Boyle's "Concerning the Unsuccessfulness of Experiments" will make the point clear.

"Having, upon occasion, had the curiosity not long since to visit some mines of lead and other metals, I find that there is a great difference, and discernible even to the eye, betwixt the several ores ; for instance, of lead, some of which I can show you so like steel, and so unlike common lead-ore ; that the workmen upon that account are pleased to call it steel-ore, which being of more difficult fusion than ordinary, they are wont to mix it with other ore, which they call firm-ore, to facilitate the melting of it. And I likewise took notice of an ore, which for its aptness to vitrify, and serve the potters to glaze their earthen vessels, the miners call pottern-ore, and sell it (at least where I saw it digged up) dearer than other ore, from which it differs both visibly enough, and as the workmen affirm in divers other (and those less obvious) qualities ; and yet all these ores, after fusion, do pass indiscriminately under the name and notion of lead. In which therefore it is no wonder, that severer inquiries find a great deal of disparity. I remember I did not long since cause some lead-ore to be tried, which being the most promising that ever I saw, made me suppose it might contain some considerable quantity of silver : but though it proved so rich in lead, as to yield after the rate of seventy pound to the hundred, yet one of the most expert artists in Europe could not extract one grain of silver out of it ; whereas the lead of very many mines, being skilfully examined, will leave behind it, upon the test, a proportion of pure silver. And though this quantity of silver be not considerable enough to make such mines as yield it pass for silver mines

Antimony.

Although there is no direct recognition of antimony as a distinct metal, some sort of allusion to it as a variety of lead is not wanting. The reason why antimony was often confounded with lead is that at first sight stibnite may be mistaken for galena. The mineral sauvirāñjana or nilāñjana was thus indiscriminately applied both to the sulphides of antimony and of lead (cf. vol. 1., pp. 98-95). That nilāñjana contained a new metal was often suspected though its nature was not properly understood. Thus in Rasendra-chūdāmazi we have "nilāñjana, mined with tikshna (cast iron), and heated several times yields a superior kind of lead which is readily fusible and is of mild black colour. •

(or, as we are wont to call them mines-royal) because the silver will not quit the cost of extracting it ; yet such mines though they pass but for lead mines with the metalist, may appear to be mixt mines to the naturalist, who may meet with divers experiments, wherein the little silver that is in them, may make their lead operate differently from that of those ores, which are wholly destitute of silver."—Edition of 1772, p. 323.

* *Vide Sans texts, p. 52.* The identical distich occurs also in R. R. S. Cf. vol. 1 p. 119. Cf. also "But to detain you no longer on the subjeot, give me only leave to strengthen the paradox I have proposed, by the authority of that great and candid chymist *Basilus Valentinus*, who speaking of antimony, after he hath told us, that there are several kinds of it, and especially two ; the one more mercurial and of a golden property, witnessed by the shining streaks or beams it abounds with ; the

**The preparation known as
Svarnasindura or makaradvaja.**

As the "law of definite proportion" was unknown to the ancients, tedious processes were resorted to for the complete conversion of mercury into its sulphide. "Makaradvaja" even at the present day is a favourite remedy with the Hindu physicians of the A'yurvedic school.* Let us follow the recipe as given in Rasendra chintámani : "when quicksilver is killed with an equal weight of purified sulphur, it becomes hundred times more efficacious ; when it is killed with twice its weight of sulphur it cures leprosy ; when it is killed with thrice its weight of sulphur it cures mental langour ; when it is killed with four times its weight of sulphur it removes grey hair and

other more full of sulphur, but destitute of the golden nature that enriches the former ; adds, that there is such a different goodness betwixt the several sorts of antimony, as there is betwixt the several sorts of flesh or fish, which, though agreeing in name and, if you please, in nature, do exceedingly differ in point of goodness, which brings into my mind the great difference which I have found, even visible to the eye, betwixt the several sorts of Antimony."—Boyle's work—i.e. p. 324.

* If we take the historical meaning of the term "A'yurvedic," the above preparation cannot lay claim to this distinction, for it was unknown at the time of the Charaka and the Susruta and was introduced into the Materia Medica during the Tantric period.

wrinkles ; when it is killed with five times its weight of sulphur it cures consumption ; and when it is killed with six times its weight of sulphur it is a panacea for all the ills that flesh is heir to.* Now 25 parts by weight of mercury can only take up (*i. e.* combine with) 4 parts by weight of sulphur ; the excess of sulphur simply sublimes off unchanged. In the actual preparation of *svarna-sindūra* (Lit. vermillion with gold) the mercury is first made into an amalgam with thin gold leaves and then repeatedly rubbed in a mortar with sulphur. During the process of sublimation (जर्जपातन) the excess of sulphur volatilises off as we have already explained and the gold in fine particles remains behind as a residue. The lustrous, crystalline, reddish brown sublimate, which collects nearest the source of heat,† has the formula HgS . As there is an erroneous impression about

* तुल्ये तु गम्यके जीर्णे गुह्याच्छतगुर्वो रसः ।

दिगुणे गम्यके जीर्णे सर्वकुड़हरः परः ॥

दिगुणे गम्यके जीर्णे सर्वजात्यविनाशनः ।

चतुर्गुणे तत्र जीर्णे बलौपलितनाशनः ॥

गम्ये पञ्चगुणे जीर्णे चयहरी इनः ।

षष्ठ्यगुणे गम्यके जीर्णे सर्वरीगहरी रसः ॥ र. ४.

† Gopalakrishna very properly lays particular stress upon this point.

खोटबिला तु मुक्ताभमूर्द्धवप्तं वलिं व्यजेत् ।

वसःस्तु रवसिष्टूं सर्वरीगेतु बोजयेत् ॥ इति रसेन्द्रवारसंवहः ।

the composition of this drug even among educated people in this country we give below the results of analysis of a sample of "mercury killed with six times its weight of sulphur along with gold."*

Identification of metals by their colouration of flames.

Prominent attention should be drawn to the following extract from *Rasárnava* (Vol. I., p. 68.)

"Copper yields a blue flame * * * * that of the Tin is pigeon-coloured ; that of the Lead is pale-tinted"

We are not aware of similar tests being applied anywhere at such an early period as a qualitative test for metals.

The age of Bhikshu Govinda the author of *Rasahridaya*.

There is a belief current in some parts of the Deccan that our Govinda is no other than the celebrated teacher of Sánkaráchárya. † If there be any historical foundation for the belief Govinda

* Percentage of sulphur found = 13·89 ; the calculated amount being 13·79 ; not a trace of gold could be detected.

† The following *Slokas* are cited from *Sánkaradigvijaya* in support of the above :—

तस्मोपदश्चिंतवत्सरको गुडावा हारे अपूजयदुपेत्व स भंकरार्यः ।
आचार इत्युपदिदेव स तच तस्मो गोविन्दपादमुरवे न गुरुर्थतोनाम् ॥

should no doubt be placed in the 8th century A. D. Apart altogether from the question whether at such an early date the progress of chemical knowledge as revealed in *Rasahridaya* had been attained in India, the colophon at the end of the work would tell against such an hypothesis (Intro. liii). The author distinctly states that he wrote his book under the auspices of the king of the Kirātas and even throws out a hint that he was of the Buddhist persuasion. We have no valid reasons to believe that Saṅkara, the sturdy champion of Brabminical faith and the mighty dialectician, whose activity proved the ruin of Buddhism in India should have sat at the feet of a Guru of the opposite creed.

व्यासः पराश्रसुतः किल सत्यवर्ती तस्याकाजः शकमुनिः प्रथितागुभावः ।
तर्जुष्ट्यतामूपगतः किल गौडपादो गोविन्दनाथमुनिरस्य च शिष्यभूतः ॥

युश्मा तस्य निकटे किल शङ्खजालं * * * *

शीमचक्रकरदिविजयः, शूमसर्गः, verses १०१ and १०५-६ ।

चानन्दाश्वसंस्कृतयन्नावलिः—यन्नारुः १२ ।

In the above Slokas Govindanātha Muni is stated to be the preceptor of Saṅkara, the former being himself the pupil of Goudapāda, who in his turn was a pupil of Sukadeva, son of Vyāsa, the well-known compiler of the Vedas. The Govinda nātha of the text has been confounded by the commentator, Dhanapati Sūri with the Buddhist Govinda. It is scarcely necessary to take serious notice of the chronological perspective of the author of the *Saṅkaradigvijaya*.

**The Mechanical, Physical and
Chemical Theories of the
Ancient Hindus.**

(*By Principal B. N. Seal.*)

I propose in this paper to give a synoptic view of the mechanical, physical and chemical theories of the ancient Hindus. A chronological survey, even if the materials for it were available, would be here of little account. The origins of Hindu natural philosophy in the speculations of the Brāhmaṇas and the Upaniṣads, or in the mythology of the Purāṇas, however interesting from the standpoint of '*cultur-geschichte*,' do not come within the scope of the present exposition, which relates to the result of systematic thought as directed to the phenomena and processes of Nature. I have therefore confined myself to an account of natural philosophy as expounded in the principal systems of Hindu thought. The Sāṅkhyā-Pātañjala system accounts for the Universe on principles of cosmic evolution, the Vaisesika-Nyāya lays down the methodology of science, and elaborates the concepts of mechanics, physics and chemistry. The Vedānta, the Pūrva-Mīmāṃsā, and in a less degree, the Baudhā, the Jaina, and the Chārvāka systems, make incidental contributions on points of special interest, but their main value in this regard is critical and negative. The principal authorities

followed in this account, —the Vyāsa Bhāshya on Patañjali's sūtras, the Saṃhitā of Charaka, the Bhāshya of Prasastapāda, the Vārttika of Uddyotakara, and the Vṛihat Saṃhitā of Varāhamihira,—all centre round the Hindu Renaissance, the beginnings of the anti-Buddhist reaction, in the fourth, fifth and sixth centuries of the Christian era. Whenever I have made use of later authors, e. g. Kumārila, Saṅkara, Śrīdhara, Vāchaspati, Udayana, Bhāskara, Jayanta, Varvara, Raghunātha, Vijñānabhikshu &c. I have taken care to see (except where the opposite is expressly mentioned) that no idea is surreptitiously introduced which is not explicitly contained in the earlier authors.

The Sāṅkhya-Patañjala System.—This system possesses a unique interest in the history of thought as embodying the earliest clear and comprehensive account of the process of cosmic evolution, viewed not as a mere metaphysical speculation but as a scientific principle based on the conservation, the transformation, and the dissipation of Energy.

Prakriti—the ultimate ground :—The manifested world is traced in the Sāṅkhya to an unmanifested ground, Prakriti, which is conceived as formless and undifferentiated, limitless and ubiquitous, indestructible and undecaying, ungrounded and uncontrolled, without beginning and without end. But the unity of Prakriti is a mere abstraction ; it is in reality an undifferentiated

manifold, an indeterminate infinite continuum of infinitesimal Reals. These Reals, termed *Gunas*, may by another abstraction be classed under three heads, (1) *Sattva*, the Essence which manifests itself in a phenomenon, and which is characterised by this tendency to manifestation, the Essence, in other words, which serves as the medium for the reflection of Intelligence, (2) *Rajas*, Energy, that which is efficient in a phenomenon, and is characterised by a tendency to do work, or overcome resistance, and (3) *Tamas*, mass or inertia, which counteracts the tendency of *Rajas* to do work, and of *Sattva* to conscious manifestation.

The ultimate factors of the Universe, then, are (1) Essence, or intelligence-stuff, (2) Energy, and (3) Matter, characterised by mass or inertia.

These *Gunas* are conceived to be Reals, substantive entities,—not however as self-subsistent or independent entities,—(*प्रधान*), but as interdependent moments in every Real or substantive Existence.

Even Energy is substantive in this sense. The infinitesimals of Energy do not possess inertia or gravity, and are not therefore material, but they possess quantum and extensity (*परिमाण—परिविस्तर*).

The very nature of Energy is to do work, to overcome resistance (*रक्षणम् उपदर्शकं*), to produce motion. All Energy is therefore ultimately kinetic. Even potential Energy (*चक्रहतुर्भवित्विक्*) is only the Energy of motion in imperceptible forms.

The original constituents and their interaction. Every phenomenon, it has been explained, consists of a three-fold *arche*, intelligible Essence, Energy, and Mass. In intimate union these enter into things as essential constitutive factors. The essence of a thing (*sattva*) is that by which it manifests itself to intelligence, and nothing exists without such manifestation in the Universe of Consciousness (सम्पर्युक्ति). But the Essence is only one of three moments. It does not possess mass or gravity, it neither offers resistance, nor does work. Next there is the element of Tamas, mass, inertia, matter-stuff, which offers resistance to motion as well as to conscious reflection. (तमः गुरु वरचकम्).

But the intelligence-stuff and the matter-stuff cannot do any work, and are devoid of productive activity in themselves. All work comes from Rajas, the principle of Energy, which overcomes the resistance of matter, and supplies even Intelligence with the Energy which it requires for its own work of conscious regulation and adaptation. (चत्वार्याभासं चहसाराभ्यां स्वकार्योपज्ञने राजसाहस्राः सहकारौ भवति सीकाचार्य-तत्त्वचय-चित्तवक्त्रता ।)

The Gunas are always uniting, separating, uniting again. (चत्वार्याभिषुभाः सर्वे, जेषामादिसत्त्वाश्वामो विशेषो वा उपकृष्टते). Everything in the world results from their peculiar arrangement and combination. Varying quantities of Essence, Energy and Mass, in varied groupings, act on one another, and

through their mutual interaction and interdependence evolve from the indefinite or qualitatively indeterminate to the definite or qualitatively determinate. (एते गुणाः परम्परोपरक्षप्रविभागाः संयोगविभागस्यर्थात् : इतरेतरोपाश्रयीष उपज्ञितमूर्तयः ।—व्यासभाष्य) . But though co-operating to produce the world of effects, these divers moments with divers tendencies never coalesce. In the phenomenal product whatever Energy there is is due to the element of Rajas, and Rajas alone ; all matter, resistance, stability is due to Tamas, and all conscious manifestation to Sattva. (परम्पराज्ञानिक्तेऽपि असंभिद्वद्विप्रविभागाः ।—व्यासभाष्य । अन्योन्याज्ञानिक्तभावेन उत्पादितेऽपि इत्ये प्रकाशतुणः सत्त्वस्येव क्षियागुणः रजस्येव स्थितिगुणसमृप एव—विज्ञानिभृत योगवार्तिक on व्यासभाष्य, ibid—नेत्रा शक्तयः स क्षीर्ण्यन्ते—वाचस्पतिमिश्र तत्त्ववेशारदी on व्यासभाष्य ibid)

The nature of the interaction is peculiar. In order that there may be evolution with transformation of Energy, there must be a disturbance of equilibrium, a preponderance of either Energy or Mass-resistance, or Essence over the other moments. The particular Guna which happens to be predominant in any phenomenon, becomes manifest in that phenomenon, and the others become latent, though their presence is inferred by their effect. For example, in any material system at rest, the Mass is patent, the Energy latent, and the conscious manifestation sub-latent. In a moving body, the Rajas, Energy, is predominant (kinetic), while the Mass or rather the Resistance

it offers is overcome. In the volitional consciousness accompanied with movement, the transformation of Energy (or work done by Rajas) goes hand in hand with the predominance of the conscious manifestation, while the matter-stuff or Mass, though latent, is to be inferred from the resistance overcome. (प्रचानवेक्षायाम् उद्दर्शितरुप्तिवाना गुच्छेऽपि च व्यापारमादेष प्रचानासन्तीतागुच्छिताभितः—ब्राह्मण)

The starting point. The starting point in the cosmic history is a condition of equilibrium or equipoise consisting in a uniform diffusion of the Reals. The tendencies to conscious manifestation as well the powers of doing work are exactly counterbalanced by the resistances of the inertia or Mass. The process of cosmic evolution (परिवाप्त) is under arrest. (सत्त्वरजसत्त्वां साम्बादस्ता प्रहृतिः— Pravachana-Sútra 61, Chap. I. साम्बादस्ता अनुमानतिरिक्तादस्ता अनुमानिकभावेन च संहतादस्ता चकाल्योदस्ता इति निर्धार्थः—विज्ञानभिष्ठ, ibid).

Beginning of Evolution. The transcendental (non-mechanical) influence of the Purusha (the Absolute) puts an end to this arrest, and initiates the process of creation. Evolution begins with the disturbance of the original equilibrium. How this is mechanically brought about is not very clear. A modern expounder of the Sánkhya supposes that the particles of Sattva, Rajas, and Tamas possess a natural affinity for other particles of their own class, and that when the transcendental influence of the Purusha ends the state of arrest, the

affinity comes into play, breaks up the uniform diffusion, and leads to unequal aggregation, and therefore, to the relative preponderance of one or more of the three Gunas over the others. Thus commences formative combination among the Reals, and consequent productive activity. (संहगमम् आरथकासंयोगः अूनाधिकभावेन आव्याप्तं संयोगविशेषः । Chap. I, Sútra 66, प्रवचनभाष्य—विज्ञानमित्रु । एूचितोव्याप्तीनां एूचितीलेनैव सुस्थव्यक्तीनाम् एकज्ञातीयतया एकता । खजातीयोपदृष्ट्यादिग्ना इतिहासादिकं च बुद्धम् :ibid., Sútra 128, Chap. I).

Formation of wholes or systems—collocation of Reals :—Creative transformation accompanied with evolution of motion (परिक्रम) and work done by Energy (क्रिया) cannot take place without a peculiar collocation of the Reals (Gunas). To form wholes or systems (उत्तुद्वय), it is essential that one Guṇa should for the moment be preponderant, and the others co-operant. And this cannot be without an unequal aggregation which overthrows the original equilibrium (बुद्धवैदेय, अूनाधिकभाव),—in other words, without unequal forces or stresses coming into play in different parts of the system. (गुच्छिमहं—वाचस्पति ।) अतः सक्षिप्तं परिक्रमत्.....उत्तुद्वयः समवायः । स च गुच्छानां गुच्छवधानम् भावमन्तर्याम न लक्ष्यते । न युच्छप्रधानभावो वैषम्यं विजा । न च वैषम्य-मुपचार्योपमर्हकभावाहसे । (वाचस्पति, कौमुदी on káriká 16.)

The Formula of Evolution—Differentiation in Integration.—Evolution (परिक्रम) in its formal aspect is defined as differentiation in the integrated (संकर-

विदेष). In other words, the process of Evolution consists in the development of the differentiated (विवर्ण) within the undifferentiated (साम्यावस्था), of the determinate (विशेष) within the indeterminate (अविशेष), of the coherent (युक्तिसिद्ध) within the incoherent (अयुक्तिसिद्ध). The evolutionary series is subject to a definite law which it cannot overstep (परिचालकमनियम). The order of succession is not from the whole to parts, nor from parts to the whole,—but ever from a relatively less differentiated, less determinate, less coherent whole to a relatively more differentiated, more determinate, more coherent whole. That the process of differentiation evolves out of 'homogeneity separate or unrelated parts, which are then integrated into a whole, and that this whole again breaks up by fresh differentiation into isolated factors for a subsequent redintegration, and so on *ad infinitum*, is a fundamental misconception of the course of material *Evolution*. That the antithesis stands over against the thesis, and that the synthesis supervenes and imposes unity *ab extra* on these two independent and mutually hostile moments is the same radical misconception as regards the dialectical form of cosmic development. On the Sāṅkhya view, increasing differentiation proceeds *pari passu* with increasing integration within the evolving whole, so that by this two-fold process what was an incoherent indeterminate homogeneous whole

evolves into a coherent determinate heterogeneous whole.

The different stadia in the order of cosmic Evolution are characterised as follows :—

- (1) The inconceivable, the unknowable, the formless, of which no character can be predicated (अविद्या), including Prakriti, or the Reals in a state of equilibrium.
- (2) The knowable, the empirical universe, cosmic matter of Experience, things as matter or stuff of consciousness (विष्व),—comprising Mahat, the intelligible Essence of the cosmos, evolved by differentiation and integration within the formless, characterless, inconceivable Prakriti.
- (3) Individuated but still indeterminate stuff bifurcating into two series—Subject-experience and Object-experience,—comprising on the one hand the indeterminate unity of apperception or the empirical Ego, as the co-ordinating principle of Subject-series (ज्ञाता), and on the other hand, the indeterminate material potencies, the subtle vehicles of potential Energy (तन्मात्र, सूक्ष्मत), the ultimate subtle constituents of the Object-series (the material world). The previous stadium, the cosmic matter of Experience (विष्व, महत्) evolves within itself,

by differentiation and integration, an individuated but still indeterminate stuff in two co-ordinated series, Subject and Object.

- (4) Determinate stuff (विशेष) evolved within the indeterminate by further differentiation and integration, viz., in the series of Subject-experience, sensory and motor stuff ; and in the Object series, a corresponding atomic matter-stuff actualising the material potencies in the form of specific sensible Energies. The latter includes the different classes of Paramāṇus, the different kinds of atomic constituents of different kinds of gross matter (स्तूपचक्र).
- (5) Coherent and integrated matter-stuff, individual substances, characterised by generic and specific properties, which however are not rigidly fixed, but fluent being subject to a three-fold change and constantly evolving, (चतुर्तिविद्यावद्यमेहात्मनः समृः इव्यग्निं पतञ्जलिः—आद्यात्, Sútra 44, Chap. III. सामान्यविद्येष्वसुदायो इवं—आद्यात्, ibid. सामान्यविद्येष्वात्मा एवयती खली, ibid. पर्याप्तां एवंकथावद्यापरिचालः).
- (6) And so the cosmic series moves on in ascending stages of unstable equilibrium (विद्युपरिचाल) until the reverse course of equilibration and dissipation of Energy

(वहूपरिचाल and शास्त्रादेश) which even now constantly accompanies the evolution and transformation of Energy, completes the disintegration of the universe into its original unmanifested ground, the unknowable Prakriti.

The order of Cosmic Evolution according to the आत्मसाक्ष (Sútra 19, Páda II) is shown below, in a tabular form :—

Prakriti, the unmanifested unknowable ground
(पृथमस्वत्तमलिङ्गः)

Cosmic matter of experience (जडत, स्वितः)

Subject series (अविशेष)	Object series (अविशेष)
Individuated indeterminate mind-stuff (unity of apperception empirical Ego, अविशेष)	Individuated but indeterminate matter-stuff (subtile material potencies, तत्त्वात्)

Determinate mind-stuff (विशेष) sensory and motor psychoses, etc. (आवेद्धित, कार्यान्वय and भवः) Determinate matter-stuff (विशेष) atomic and molecular constituents of gross matter (परमाणु—सूक्ष्मूत्र)

Coherent and integrated
matter-stuff (अयुतसिद्धावयवः
समृष्टः सहातः द्रव्यं)

Individual substances, with generic and specific characters subject to constant change or evolution e.g. inorganic objects composed of atoms or molecules (परमाणु), vegetable organisms (हृष्ट), animal organisms (शरीर) (अयुतसिद्धावयवः सहातः शरीरं हृष्टः परमाणुरिति—व्यासभाष्य, Sútra 44, Páda III).

तत् तत् संख्येण विविच्यते क्रमान्वांतङ्गेः, तथा पङ्कविशेषाः सिद्धमावे संस्कृता विविच्यन्ते, परिचामक्रमनियमात्, तथा तेषु अविशेषेषु भूतेन्द्रियाणि संस्कृतानि विविच्यन्ते, न विशेषेभ्यः परं तत्त्वान्वरमस्ति तेषान्तु धर्मलक्षणावस्थापरिवामा व्याख्यायिष्यन्ते (व्यासभाष्य, Sútra 19, Páda II).

N.B.—The usual order given in the Sánkhya compendiums is as follows :—Prakriti, Mahat, Ahaṅkára,—and then the bifurcation, viz., 11 organs sensory, motor and common sensori-motor from Rájasic Ahaṅkára, and Tanmátras from Támasic Ahaṅkára,—and finally the Paramánus of the Sthúla-Bhútas.

The conservation of Energy (and of Mass)—the transformation of Energy :—

The Gunas (Reals), though assuming an infinite diversity of forms and powers, can neither be created

nor destroyed. The totality of the Mass (Tamas), as well as of Energy (Rajas) remains constant, if we take account both of the manifested and the unmanifested, the actual and the potential. But the individual products of the evolutionary process, the concrete phenomenal modes resulting from the combined action of the original Mass, Energy and Essence, are subject to addition and subtraction, growth and decay, which are only due to changes of collocation, and consequent changes of state from the potential to the actual, (in other words, from the future to the present and from the present to the past, in a time series)—changes, which are illusorily ascribed to the Reals themselves. The different collocations of Mass and Energy give birth to the divers powers of things, the various forms of Energy which may be classed as like and unlike ; indeed the course of Evolution from the Reals conforms to a fixed law, not only as regards the order of succession, but also as regards the appearance (and mutual relations) of like and unlike Energies. And this transformation is constantly going on,—the course of Evolution is not arrested for a moment.

गुणात् सर्ववर्णानुपातिः न प्रवक्षनयने नीपजायने व्यक्तिभिरेकं चतोत्ताइनागतव्यागमवस्तीभिः गुणात्प्रयोगिभिः उपजनापायवर्णका इव प्रवक्षनात्मने (व्यासभाष्य, Sútra 19, Páda II). परिवर्णनित्यता गुणानाम् । सर्वविदं गुणाना सत्त्वविशेषमात्रम् (*ibid*, Sútra 13, Páda IV). एते गुणः तु लक्षातीयातुलक्षातीयव्यक्तिभेदानुपातिः (*ibid*, Sútra 19, Páda II). परिषामक्रमनियमात् (व्यासभाष्य,

Sútra 19, Páda II). ऋग्वेद' परिचालात्मके देतु. (*Patañjali* Sútra 15, Páda III). प्रज्ञायः परिचमवौद्धा चचम्परिचम्ना यतिहै ।

The doctrine of Causation, a corollary from the conservation and transformation of Energy :—the principle of collocation—the storing-up and the liberation of Energy :—

The Sánkhya view of causation follows at once as a corollary from this doctrine of the conservation and transformation of Energy. As the total Energy remains the same, while the world is constantly evolving, cause and effect are only more or less evolved forms of the same ultimate Energy. The sum of effects exists in the sum of causes in a potential (or un-evolved) form. The grouping or collocation alone changes, and this brings on the manifestation of the latent powers of the Gunas but without creation of anything new. What is called the (material) cause or sum of material causes is only the power which is efficient in the production or rather the vehicle of the power. This power is the unmanifested (or potential) form of the Energy set free (चक्षुषस्त्र) in the effect. But the concomitant conditions are necessary to call forth the so-called material cause into activity. When the favourable combination or co-operation of concomitants is wanting, there is no manifestation of the effect. The question is—what is the aid which the concomitant conditions render to the deter-

mination (and production) of the effect existing in potency in its material cause ? First there is the merely mechanical view as illustrated by some commonplace examples, e.g., the manifestation of the figure of the statue in the marble block by the causal efficiency of the sculptor's art, or of the oil in the sesamum by pressing, or of the grain of rice out of the paddy by the process of husking. In these cases the manifestation of an effect is only its passage from potentiality to actuality, a stadium in the process of evolution from possible (future) existence to actual (present) existence ; and the concomitant condition (सहकारित्वम्) or efficient cause (निमित्तकारण), the sculptor's chiselling, the pressing, the husking, is a sort of mechanical or instrumental help to this passage or transition. कार्यस्त्रियमस्तमेव उपादान-कारणत्वम् । सा ब्रह्मः कार्यस्य अनागतावस्था एव । स एव विशेषः (उत्पत्ते : प्राक् कारणे विशेषः) अभाविः कार्यस्य अनागतावस्था इत्युच्चते (विज्ञानभिक्षु-प्रबचनभाष्य, Sūtra 115, Chap. I). अभिव्यक्तिः वर्तमानावस्था । कारणव्यापारीऽपि कार्यस्य वर्तमानतत्त्वपरिचालनेव अनयति । यथा शिळामध्यस्थप्रतिमावाः खेत्रिक-व्यापारीक अभिव्यक्तिमादं तिवस्तेतत्स्य च निष्पोषेन धार्यस्तत्त्वुलम्य च अवशालेन (विज्ञानभिक्षु-प्रबचनभाष्य, Sūtra 129, Chap. I).

These mechanical examples of the Kapila-Sāṅkhya have the merit of simplicity, but the Patañjali-Sāṅkhya brushes them aside, and explains causation on the basis of the conservation and transformation of Energy, advancing it as the liberation of potential Energy existing

stored up in a Guna collocation, (the sum of material causes) the liberation following on the action of the proximate efficient cause, or concomitant condition (निमित्तकारण).

The causal operation of concomitant conditions (efficient causes) lies only in this that they supply a physical stimulus which liberates the potential Energy stored-up in a given collocation. Everything in the phenomenal world is but a special collocation of the ultimate Reals (Energy, Mass and Essence). The sum of (material) causes potentially contains the Energy manifested in the sum of effects ; and in the passage from potency to actualisation, the effectuating condition (the concomitant cause) when it is itself accomplished, is only a step in the evolutionary series, which adds a specific stimulus, and renders determinate that which was previously indeterminate. When the effectuating condition is added to the sum of material conditions, in a given collocation, all that happens is that a stimulus is imparted, which removes the arrest, disturbs the relatively stable equilibrium, and brings on a liberation of Energy (उद्युत्तर्हतिः) together with a fresh collocation (गुणसङ्कलनविभ्रमः). सर्वमिदं गुणानां सञ्चितेष्विषयमादन् ४५ परमार्थतो गुणाकाणः (ब्राह्मण, Sútra 13, Páda IV). उदय फलम् निमित्तं वर्तमानीकरणे उपर्युक्तं न अपूर्वोपज्ञनम् । सिद्धं निमित्तं निमित्तकारणं विदेशानुयायक ब्रह्मते । नापूर्वमुख्यादयति (ब्राह्मण, Sútra 12, Páda IV).

Describing the production of bodies ('organic vehicles') for individual souls, out of matter of Prakriti, under the influence of their merit and demerit, as concomitant conditions, Patañjali points out that non-material concomitants like merit and demerit do not supply any moving force or Energy to the sum of material conditions, but only remove the arrest (the state of relatively stable equilibrium) in a given collocation, even as the owner of a field removes the barrier in flooding his field from a reservoir of water. This description is intended to represent the super-physical influence of non-material concomitants (or causes) like volition, merit and demerit, etc., but the causal operation of a material concomitant condition is essentially the same;—there is the same reservoir of stored-up Energy in a given collocation,—the same condition of arrest or relatively stable equilibrium,—the same liberation of the stored-up potential Energy which flows along the line of least resistance;—the only difference being that in the case of material concomitants the stimulus which removes the arrest is physical, instead of being transcendental as in the case of non-material causes like will, merit and demerit, etc.

The Vyāsa-bhāshya helps us to a clear mental representation of the details of this process, being perhaps the finest example before Newton of the exercise of a Scientific Imagination, and as memor-

able as any in the whole history of thought containing as it does the theory of potentials as in a nutshell :—As the owner of many fields can irrigate, from a field which is already flooded, others of the same or a lower level, without forcing the waters thereto with his hands, and merely by making an opening in the barrier or dyke, on which the waters rush in by their own force ;—or further, as the same person cannot force these waters, or the earthy matters held in solution therein, into the roots of the rice plants, but only removes the obstructive grasses and weeds, on which the fluids of their own power enter the roots ;—such is the action of an effectuating condition (निमित्त) added to a sum of material causes or conditions.

निमित्तम् अप्रयोजकं प्रहृतीगति वरणमेदस्य ततः चेतिकवत् (*Patañjali Sútra* 3, Páda IV). न हि धर्मादि निमित्तं यथा चेतिकः केदारात् अपां घृतात् केदारे पित्रावयिषुः सर्वं गिर्वा वा निष्ठतर्वा वा नापः पातिनापकर्त्ति आवरणं तु आसा भिन्नति तद्विग्नं भिन्ने स्थमेवापः केदाराकरम् आप्नावयन्ति ।

Chain of Causation—fixed order.—The order of Evolution with the transformation of the Energies follows a definite law. The unalterable chain of causes and effects in the phenomenal world illustrates this fixed order. But though the cosmic order is one and fixed, it comprehends divers series arising from different combinations of the original Gunas, which constitute subordinate or particular laws of cause and effect (क्रमावल्ल परिचामावले हेतुः, *Patañjali Sútra* 15, Páda III).

What we call the qualities of things are only modes of Energy acting in those collocations.

योग्यतावच्छिद्धा चर्याः प्रकृतिरेव धर्मः— स च फलप्रसवमेदातुभित्तिसद्ग्रावः (व्यासभाष्य, Sútra 14, Páda III). ते खल्लमी धर्मा वर्तमाना अत्यन्तान्तः, अतीताऽनागताः सूक्ष्मानानः सर्वमिदं गुणानां सन्निवेशमात्मनिति परमार्थस्तो गुणात्मानः (व्यासभाष्य, Sútra 3, Páda IV). And these various Energies are sometimes actual (kinetic), sometimes potential, rising to actuality, and sometimes sublatent, subsiding from actuality into sublatency. In fact, the original Energy is one and ubiquitous, and everything therefore exists in everything else, *potentialiter* (सर्वं सर्वात्मकमिति), without prejudice to the generic and specific differences of things (जात्यनुच्छेदेन सर्वं सर्वात्मकं). Inorganic matter, vegetable organisms, and animal organisms are essentially and ultimately one (जलभूम्यः पारिष्ठामिकं रसादिवैश्वर्यं स्थापरेषु ह एव तथा स्थापराणां जडमेषु जडमानां स्थापरेषु) so far as Mass and Energy are concerned, but the varied forms of Energy and the generic and specific qualities (or properties) of things, which are but modes of Energy, follow a definite unalterable law in the order of their appearance and succession, under conditions of space, time, mode and causality, and hence all effects do not manifest themselves at once देशकालाकारनिमित्तापव्याप् त न खलु समानकालम् आत्मनामभिव्यक्तिः (ibid, Sútra 14, Páda III). यो यस्य धर्मस्य समन्वयो धर्मः स तस्य क्रमः। पिण्डः प्रथ्यवते घट उपजायते इति धर्मपरिणामक्रमः। लक्षणापरिणामक्रमः घटस्य अनागतभावात् वर्तमानभावक्रमः, तथा पिण्डस्य वर्तमानभावात् अतीतभावक्रमः (व्यासभाष्य, Sútra 15, Páda III).

(and therefore of time, चक्र). If this is held to be an irreducible absolute unit, it will follow that what we represent as the time-continuum is really discrete. Time is of one dimension. Two moments cannot co-exist. Neither does any series of moments exist in reality: Order in Time is nothing but the relation of antecedence and sequence, between the moment that is, and the moment that went just before. But only one moment, the present , exists. The future and the past have no meaning apart from potential and sublatent phenomena. One kind of transformation, to which a thing is subject, is that it changes from the potential to the actual, and from the actual to the sublatent. This may be called the change of mark (लक्षणपरिवर्तनम्) as opposed to change of quality (धर्मपरिवर्तनम्), and the change due to duration or lapse of time (चक्रापरिवर्तनम्). The present is the mark of actuality,—the future, the mark of potentiality,—and the past, of sublatency,—in a phenomenon. Only one single moment is actual, and the whole Universe evolves in that one single moment. The rest is but potential or sublatent.

चक्रतत्क्रमयोर्निः किं वसुसमाहारः इति बुद्धिसमाहारः सुहर्ताङ्गीरवाद्यः ।
स खल्यं कालः वसुश्च बुद्धिनिर्णयः शब्दशानानुपाती लौकिकान्
व्यत्तितदर्थगान् वसुसर्वप इव अवभासते । चण्डु वसुपतिक्रमः वलम्बौ ।
क्रमयचाणान्तर्यामा । तं कालविदः काल इति आचक्षते योगिनः । न च
हो ज्ञाने सह भवतः, क्रमय न इयोः सहभूदीरसच्चादात् पूर्वकादुपरभाविनो
बदानन्तर्य चक्रस्य स क्रमः । तत्त्वात् वर्तमान एवेक्षः चण्डः न पूर्णो तरचक्रः ।

सत्कौति तत्त्वान्नास्ति तत्त्वमाहारः । ये तु भूतभावितः चत्वाः ते परिणामान्विता
व्याख्येयाः । तेजेति चर्येत् छत्वाः खोकः परिणामसंग्रहवति, तत्त्वचारकः
खलमी चर्याः । यद्याऽपकर्वयन्तं द्रव्यं परमाणुः एव परमापकर्वयन्तः
कालः चत्वाः । यद्यता वा समयेत् चलितः परमाणुः पूर्वदेशं जडात्
उच्चरदेशम् उपस्थितेत् स कालः चत्वाः तत्प्रवाहाविच्छेदस्तु क्रमः । (व्याख्यात
Sutra 52, Pada III.)

Vijnâna-bhikshu points out that this does not amount to a denial of Time. It means that time has no real (or objective) existence apart from the 'moment'. But the latter is real, being identical with the unit of change in phenomena (गुणपरिणामस चत्वात्). But even this is real only for our empirical (relative) consciousness (अत्यितदर्शन), which intuits the relation of antecedence and sequence into the evolving Reals (Gunas), in the stage of 'empirical intuition' (सविचारा निर्विकल्पप्रज्ञा). The 'intellectual intuition' (निर्विचारा निर्विकल्पप्रज्ञा) on the other hand, apprehends the Reals as they are, without the empirical imported relations of Space, Time and Causality.

Space as extension and Space as position :—

Space must be distinguished as Desa (locus, or rather extension) and Dik (relative position). Space (Dik) as the totality of position, or as an order of co-existent points, is wholly relative to the Understanding, like order in time, being constructed on the basis of relations of position intuited by our empirical (or relative) consciousness. But there is this difference between Space-order and Time-order :—there is no unit of Space as position (Dik),

though we may conceive a unit of Time, viz., the moment (चक्र) regarded as the unit of change in the phenomenal or causal series (परमाणुक्तिः or गुणपरिवामल चक्रत्वपनात्—योगवाचिक, Sutra 51, Pada III). Spatial position (Dik) results only from the different relations in which the all-pervasive Akāsa stands to the various finite (or bounded) objects. On the other hand, Space as extension or locus of a finite body, Desa (देशः स्थित्याभावः), has an ultimate unit, being analysable into the infinitesimal extensive quantity inherent in the Reals (Gunas) of Prakṛiti. (गुणप्रकृति-रज्जुपरिवामः—योगवाचिक । एतेन निष्ठा दिग्पि चण्डमाणिको व्याप्त्यात्, सामान्यतो दिग्ब्यवहारभावात् । पूर्वादिग्ब्यवहारस्य दिग्गुपाधिभिरेव सम्भवात् सामान्यतः कालदिग्ब्यवहारस्त्वेऽपि आकाशादेव तदुपपत्तेष । कालाद्य दिग्मयं विशेषः यत् कालः चक्रप इष्यते, दिक् तु सर्वथैव नेत्रते ।

The Casual series.—The relation of Cause and Effect has been already explained. It only remains to add that the category of causality is mediated through the *schema* of order in Time. The Empirical Intuition first superimposes relations of antecedence and sequence on changing phenomena (the evolving Gunas or Reals), and the Understanding out of these relations creates order in Time. The Empirical Intuition then intuits the phenomenal series of transformations of Energy in this Time-order and in so doing, imports the relation of cause and effect into the course of Nature. (कार्यकारणभावादीनां चक्रटित्वात्—योगवाचिक, Sutra 51, Pada III).

The dissipation of Energy (and of Mass)—their dissolution into the formless Prakriti:—Cosmic Evolution (परिवाप) is a two-fold process, creative as well as destructive, dissimilative as well as assimilative, katabolic as well as anabolic (अनुकूलमसर्वं and विनीमसर्वं, विस्फृप्तपरिवाप and सहस्रपरिवाप). In one aspect, there is the aggregation (unequal aggregation) of Mass and Energy, with consequent transformation of Energy, resulting in the creation of inorganic as well as organic matter, and the genesis of worlds. The successive steps of this process may be described as (1) unequal aggregation with storing-up of Energy in a certain collocation, under a state of arrest (*i. e.*, in a state of relatively stable equilibrium), (2) a stimulus removing the arrest, and disturbing the equilibrium, and (3) liberation of the Energy, moving on to a fresh collocation, fresh aggregation, arrest and equilibrium. The process of the world thus moves on from equilibrium to equilibrium, and the result of that process is the development of a coherent determinate heterogeneous whole (लिङ्ग अविशेष विशेष, अयुतसिद्धावयवसमूह, युतसिद्धावयवसमूह) in what is essentially an incoherent indeterminate homogeneous whole (अलिङ्ग).

But there is a second aspect of this evolutionary process. Unequal aggregations are unstable, there is a constant tendency in things to go back to the original stable equilibrium,

the state of uniform equal diffusion of Reals. This process is called the resolution of like to like (रहस्यपरिवाप), consisting in assimilation and dissipation, and being the exact opposite of the process of "differentiation in the integrated" which has evolved the Cosmos. The collocations of Mass, Energy and Essence are always breaking up, and the Energy as well as the Mass, however slowly, however imperceptibly, are being dissipated, i. e., dissolved into the original formless Prakṛiti, a state of permanent equilibrium and arrest, from which there is and can be no return, except under the transcendental influence of the Absolute at the commencement of a new creative cycle. Not that there is a destruction of the Mass or Energy, but a dissipation or dissolution into a condition of equal uniform diffusion from which there is no return. This is not the phenomenon of kinetic Energy disappearing and becoming potential or sublatent, for in such cases there is restitution or reconversion by natural means. When this reverse current of assimilation (and dissipation) prevails over the current of dissimilation (and integration), the Universe will disintegrate more and more, until it disappears in the formless Prakṛiti, its unknowable source and ground (रहस्यवद् एवं कीलुदे).

The Evolution of matter (तात्त्वादिक चक्र) :—

The ultimate constitution of Matter is a question of the profoundest interest in the Sāṅkhya-Pātañ-

jala system. Three stages clearly stand out in the genesis of Matter :—(1) the original infinitesimal units of Mass or inertia, absolutely homogeneous and ubiquitous, on which Energy does work, when the original equilibrium comes to an end (भूतादि—तामसाहार), (2) The infra-atomic unit potentials, charged with different kinds of Energy, which result from the action of Energy on the original units of Mass, (तन्मात्र), and (3) the five different classes of atoms, the minutest divisions of which gross matter is capable, but which are themselves complex Tanmátric systems (सूखमूतपरमाणु).

The first stadium Bhútádi is absolutely homogeneous and absolutely inert, being devoid of all physical and chemical characters (उपादिभिरसंयुत) except quantum or mass (परिच्छिन्नत. परिमाण); and this admits neither of addition nor of subtraction, can neither be created nor destroyed. The second stadium Tanmátra represents subtle matter, vibratory, impinging, radiant, etc., instinct with potential energy. These potentials arise from the unequal aggregation of the original mass-units in different proportions and collocations with an unequal distribution of the original Energy (Rújas). (तन्मात्र उपादि: किं कारकम् इति चेत् सकारणदद्व्याक्षां शूलाचिकामादेन अन्योन्यं परि संबोधविशेष एव—सजातोयोपष्टभादिना हिङ्गासादिकं च युक्तं.) The Tanmátras possess something more than quantum of Mass and Energy. They possess physical characters, some of them penetrability

(अवकाशदात्र), others powers of impact or pressure, others radiant heat, others again capability of viscous and cohesive attraction. In intimate relation to these physical characters they also possess the potentials of the energies represented by sound, touch, colour, taste and smell, but being subtle matter they are devoid of the peculiar forms (विशेष) which these potentials assume in particles of gross matter like the atoms and their aggregates. In other words, the potentials lodged in subtle matter must undergo peculiar transformations by new groupings or collocations to be classed among sensory stimuli,—gross matter being supposed to be matter endued with properties of the class of sensory stimuli, though in the minutest particles thereof the sensory stimuli may be infra-sensible (अतीन्द्रिय but not अशृहत). (तन्मात्राः सर्वाणि संस्कृतानां ते च अविशेषिष्यते । ते च पदार्थाः आत्मचोरमूढाश्चाः खूलगत-मष्टादिविशेषेः शूक्रा एकरूपत्वात् । तथा च आत्मादिविशेषशूलगत-मष्टादिविशेषावलम्ब ।)

The Tanmátras, then, are infra atomic particles charged with specific potential energies,—first, the potential of the sound stimulus is lodged in one class of particles, Tanmátras which possess the physical energy of vibration (परिअन्द) and serve to form the radicle of the ether atom (आकाशपरमाणु), then the potential of the tactile stimulus is lodged in another class of Tanmátras, particles which possess the physical

energy of impact or mechanical pressure in addition to that of vibration and serve to form the radicle of the gas atom (Váyu Paramánu);—next, the potential of the colour stimulus is lodged in a third class of Tanmátras, particles which are charged with the energy of radiant heat and light in addition to those of impact and vibration and serve to form the nucleus of the light and heat corpuscle; then the potential of the taste-stimulus is lodged in other Tanmátras, particles which possess the energy of viscous attraction, in addition to those of heat, impact and vibration, and which afterwards develop into the atom of water, and lastly, the potential of the smell-stimulus is lodged in a further class of Tamátras, particles which are charged with the energy of cohesive attraction, in addition to those of viscous attraction, heat, impact and vibration and which serve to form the radicle of the earth-atom.

बहुविशेषाः सत्याः ग्रन्थतन्मावं स्पर्शतन्मावं रसतन्मावं
गम्भतन्मावं। चक्र दूष्येन्द्रियित्वा तु प्रथमस्तु चेष्टाः। ग्रन्थादयः प्राणविशेषाः। व्यासभाष्य,
Sutra 19 Pada II अहङ्कारात् ग्रन्थतन्मावं रसतन्मावं गम्भतन्मावं
ग्रन्थतन्मावात् ग्रन्थपर्यनुयं स्पर्शतन्मावम्। एवंकलमेष्ट एकंकगुणात्मका
तन्मावाचि सत्यदात्रे (प्रवचनभाष्य—Sutra 62, Chap. I).

ब्रह्मदीनो मूर्तिस्तमानानीयानाम् एकः परिचालः पृथिवीपरकाञ्चुः
तन्मावाववयः। मूर्तालैदृष्टि क्षमि लैहीच्छप्रवामित्वाऽप्यकाशदानानि उपादाय
साक्षात्म् एकविकारारम्भः समाधिदः। (व्यासभाष्य, Sutra 14.
Pada IV.) तत्याः। गम्भतन्मावं ग्रन्थयित्वा चतुर्थतन्मावाचि देहादीवानाम्

एकः परिकामः अलपरमाणुः तेषां च महाजलाद्विः, एवं गन्धरसौ वज्रं विला
चीष्यानातोयानि चितन्नादाणां तेजोऽनुः तेभ्यः महातेजसःदिः। एवं
गन्धरसदपाणां वर्जनात् द्वाभ्यां वायुणः तेभ्यः महावायुदिः। एवं शब्दतन्मात्रा-
दहस्तारामधुहस्तात् आकाशाणः तेभ्यः महाआकाशदिः।

विज्ञानभिल्लु remarks :—अब इर्द्दने अयं सिद्धान्तः शब्दादि-
तन्मात्रपद्धतिके वाटिक्यदेहादिव्यङ्गाः पृथिवीत्वादिकातयः सन्ति। (योगवार्तिक,
Sutra 14, Pada IV.)

Before explaining the genesis of atoms, it is necessary to say something about *A'kasa*, which is the link between the infra-atomic particles (*Tanmátras*), and atoms (*Paramánus*). *A'kasa* corresponds, in some respects to the ether of the physicists and in others to what may be called proto-atom (*protyle*). In one respect *A'kasa* is all-pervasive (विसु), and devoid of the property of impenetrability which characterises even the infra-atomic potential units (*Tanmátras*). In another aspect, *A'kasa* is described as having originated out of the mass or inertia in *Prakriti* (*Bhútádi*) when the latter became charged with the first potential vibration (the sound-potential). *Vijnána-bhiksnu* in the *Yoga-Vártika* boldly tackles the difficulty. *A'kasa*, he explains, has two forms, original and derivative, non-atomic and atomic. The original *A'kasa* is the undifferentiated formless *Tamas* (mass in *Prakriti*, matter-rudiment—*Bhútádi*) which is devoid of all potentials, and is merely the all-pervasive seat or vehicle of the ubiquitous original Energy (*Rajas*). This *A'kasa*

must not be confounded with vacuum, which is merely negative (आवरणाभाव—un-occupiedness), though it must be conceived as all pervasive, occupying the same space as the various forms of gross matter (समानदेशकम्—अवकाशसंकरम् आकाशं—योगवार्तिक), and therefore devoid of the property of impenetrability (मूर्खान्तरासमानदेशतं—योगवार्तिक) which characterises atomic matter. But when the original equilibrium (साम्यावस्था) comes to an end, unequal aggregations form collocations in different groups and proportions of the three Gunas (गुणाधिकभावेण अन्तर्बोधं संयोगविशेषः संहृष्टम्—विकालभित्ति, प्रदचनभाव and योगवार्तिक). The transformation of Energy now begins,—working on a collocation of mass (with Essence) (गुणान्तरोप-सम्बन्धं सदैश्वतः—विकालभित्ति, योगवार्तिक); it first gives rise to the sound potential (अद्वजमनयीग्यायंकर्पेण परिवर्तति—विकालभित्ति) and the atomic Akāsa (proto-atom, protyle) is but an integration of the original unit of mass charged with this vibration potential. This vibratory (or rather rotary) ether-atom (आकाशाण्ड) is integrated, limited (परिचक्षित) and as such cannot occupy the same space with other (subsequently integrated) atoms. But this proto-atomic integration of Akāsa (काव्योकाश) is formed everywhere, and itself residing in the ubiquitous non-atomic Akāsa (कारणाकाश—अवकाशसंकरम् आकाशं) forms the universal medium in which air or gas atoms, light and heat corpuscles, and ether atoms move and float about. (आक्षीरावरणं। यदि हि अवकाशसंकरम् ‘आकाशं

न स्यात् तदा मृत्तिंद्रव्येषु स्यात्क्षादिषु अस्तक्षेत्रादिप्रवैश्वी न स्यात्—
विज्ञानभिष्ठ, योगवार्त्तिक Sutra 40, Pada III. आकाशं हि
कार्यात्मारचनयेण विविधम्। इति कारणाकाशं तमोगुच्छविशेषतयैव
व्यवङ्गियते। तटानीम् आकाशात्मकशब्दादिगुच्छविशेषाभावात्। तत्त्व
कारणाकाशं गुच्छात्मरसम्बन्धं सदृशतः आदौ शब्दात्मनवीन्यार्थप्रयोगं परिणयमते
तत्त्वं च चुस्तुतेन पृथिवीवदेव महाभूताकाशम् अहस्तारामेच्या परिणामं
वायीरावरणम् उत्पदयते (विज्ञानभिष्ठ, योगवार्त्तिक, Sutra 41, Pada III).

The genesis of the infra-atomic unit-potentials (Tanmátras) and of the atoms.

The subject of the genesis and the structure of the Tanmátras and the Paramánus was a fascinating one to these ancient thinkers. and a wide divergence of views prevailed. I will here notice several typical views :—those of the Vishnu Purána, Parásara, Patañjali and a certain School of Vedantists reported in the तत्त्वनिष्ठपत्र.

1. A famous passage in the Vishnu Purána explains the genesis and the structure of the Tanmátras and of the Bhútas (Paramánus) in the following manner :—

The first Tanmátra originated from the rudiment-matter (Bhútádi), the individuated but still indeterminate potential-less Mass in Prakriti under the action of Energy (उपद्रवः परिवर्त्यात्—प्रवचनमात्, Sutra 66, Ch. I.) by a process of disintegration and emanation (विज्ञानम्—विष्णुपुराण—एकविकारारथः—व्यासभाष्य, Sutra 14, Pada IV. विज्ञानम्: विकोर्चितास्तमात् व्यापिता इति

यावत्, योगवाचिक on *Patañjali's Sutra*.—मनोजवित्तं विकरणभावः etc.) in the menstruum, or surrounding medium of the unindividuated Cosmic Mass (Mahat) (महताहतः).

This first subtle matter, the first result of 'Mass disintegration' and Energy-transformation, is charged with the sound-potential, the potential of vibration or oscillation (परिष्वन्द). It is called the sound-potential (शब्दसमावा॑द)

This is typical of the genesis (and structure) of the other Tanmátras (kinds of subtle matter). In each of the remaining cases, an atomic Mass charged with actual specific energies (भूतपरमाणु) disintegrates and emanates, and thus evolves a form of subtle matter (a kind of Tanmátra) under the action of Energy, and always in the same menstruum or surrounding medium,—that of Bhútádi, the super-subtile. Each kind of subtle matter becomes charged with a new potential in addition to the potentials already evolved. The genesis of an atom, Bhúta-Paramánu, is a quite different process. Here the unit potential (Tanmátra) receives an accretion of Mass, and by a sort of condensation and collocation evolves an atom (Bhúta-Paramánu).

The genesis and structure of the Tanmátras and the Bhúta-Paramánus are worked out below :—

- i. The super-subtile individuated Mass (rudiment matter (Bhútádi), under the action of the

original Energy (रजः) disintegrates and emanates (विकृते) in the menstruum or surrounding medium (समावरण) of Mahat, cosmic super-subtile Mass, and evolves a form of subtile matter (तन्मात्र), which becomes charged with the sound-potential (vibration-potential, परिष्वर्ण), and is called the unit of sound-potential (शब्दतन्मात्र).

2. This subtile matter, the Mass, charged with sound-potential, receives an accretion of Mass from the rudiment matter (Bhútádi) and by condensation and collocation evolves the A'kásá Bhúta, the atomic A'kásá, the proto-atom charged with the specific energy of the sound stimulus (actual vibratory motion.) (स एव भूतादिः शब्द-तन्मात्रात् स्वितीयात् शब्दगुणकाम् आकाशं सपर्यं । तथा च अहस्तारशब्दतन्मात्राभ्यां मिलिता आकाशं सृज्यते,—श्रीगवार्षिक on the Vishnu Purána passage, Sutra 14, Pada IV).
3. This proto-atom, the atomic A'kásá, charged with its actual specific energy, again disintegrates and emanates, under the action of the original Energy, and in the menstruum of the rudiment-matter (super-subtile Mass) and thus evolves another kind of subtile matter (Tanmátra) which becomes charged with the touch-potential (the potential of impact or mechanical pressure

(प्रकाशित, वहन-ज्ञौलता) in addition to the sound-potential (vibration-potential—परिक्षम्) and is called the unit of touch-potential (स्पर्शतन्मात्र).

4. Next, this subtle matter, the mass charged with touch (and sound) potential, i.e., with the potentials of vibration and impact, receives an accretion of mass again from the rudiment-matter (Bhútádi) and by condensation and collocation, evolves the Váyu Bhúta, a kind of gaseous matter or air of which the atoms are charged with the actual specific energy of the touch stimulus, i.e., with actual energy of impact in addition to the actual energy of vibratory motion.
5. Next, the atom of Váyu, so charged with the actual specific energy of impact and vibration, again disintegrates and emanates, under the action of the original Energy, and in the same menstruum or surrounding medium of the rudiment matter (super-subtile Mass—Bhútádi) and thus evolves another kind of subtle matter (Tanmátr), which becomes charged with the heat-potential (चौषध) — चूषध—heat-and-light-potential) in addition to the impact-potential and the vibration-potential, and is called the unit of colour-potential (कल्पतन्मात्र).

6. Now this subtle matter, this radiant matter, charged with light-and heat-potential, and also with impact and vibration-potential, receives an accretion of Mass again from the rudiment-matter (Bhútádi), and by condensation and collocation evolves the Tejas Bhúta, the light-and-heat-corpuscle, which is charged with the specific Energy of the colour-stimulus, i.e., radiates actual heat and light (विकरण) in addition to manifesting the energy of impact (impingency) and of vibration (or oscillation).
7. Next, this atom or light-and-heat-corpuscle disintegrates, and emanates as before a form of subtle matter charged with the taste-potential (रसतापाच), in addition to the three potentials already generated, and also with the physical potential of viscous attraction.
8. This subtle matter charged with the taste-potential and with the potential of viscous attraction condenses and collocates as before into the water-atom which manifests the actual specific energies of viscous attraction and the taste-stimulus.
9. The viscous water-atom charged with the actual specific Energy of the taste stimulus disintegrates, and emanates as before a form of subtle matter charged with the

smell-potential in addition to the four potentials already generated and also with the potential of cohesive attraction.

10. This subtle matter charged with the smell-potential and with the potential of cohesive attraction condenses and collocates as before into the earth-atom, which manifests the actual specific Energies of cohesive attraction and the smell-stimulus.

Vijñána bhikshu in the Yoga-Vártika briefly summarises the Vishnu Purána process as follows :—

Bhútádi as radicle in conjunction with Mahat produces the sound potential, which as radicle in conjunction with Bhútádi produces A'kása, which as radicle in conjunction with Bhútádi produces the touch-potential, which as radicle in conjunction with Bhútádi produces Váyu, which as radicle in conjunction with Bhútádi produces the colour-potential, which as radicle in conjunction with Bhútádi produces Tejas and so on.

In this brief summary he does not bring out the force of विकृचारः (the disintegrating process), and the distinction between the genesis of subtle and gross matter (Tanmátra and Bhúta).

वस्ता प्रधानेन महता, महता स तथाहतः ।
भूतादिषु विकृचारः सर्वे तन्मात्रिकं ततः ।

सर्वं ब्रह्मतन्मातात् चाकाशं ब्रह्मतन्मात् ।
 अद्भुतं तदाकाशं भूतादिः संसाहेत् ।
 चाकाशस्य विकृत्वादः अद्भुतं सर्वं ह ।
 तदवान् अभवत् वायुः तत् अर्द्धे गुणो मतः । (विष्णुपुराण)

11. A famous passage in Parásara takes another view of the genesis and structure of the Tanmátras and the Bhúta-Paramánus. Krishnapáda, in the तत्त्वविद्यरथ, represents the scheme as follows :—

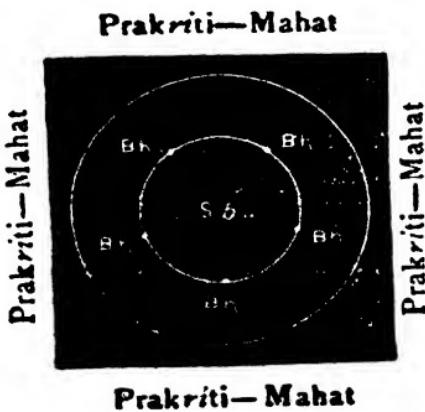
The Tanmátras originate from one another in one linear series, and each Bhúta originates in a separate line from its own Tanmátra.—

भूतादि (Bhútádi)

ब्रह्मतन्मात्	Sound-Tanmátra—as a radicle or centre surrounded or encircled by Bhútádi generates Akása.
अर्द्धतन्मात्	Touch-Tanmátra—as a radicle or centre encircled by Sound-Tanmátra with Akása-atom as a help generates Váyu—
कल्पतन्मात्	Colour-Tanmátra—as a radicle or centre encircled by Touch-Tanmátra with Váyu-atom as a help generates Tejas—
रसतन्मात्	Taste-Tanmátra—as a radicle or centre encircled by Colour-Tanmátra with Tejas-atom as a help generates Ap—
गम्भतन्मात्	Smell-Tanmátra—as a radicle or centre encircled by Taste-Tanmátra with Ap-atom as a help generates Prithivi.

The genesis of a Bhúta-Paramánu (atom) from the subtle matter of a Tanmátra is not here so simple as in the view of the Vishnu Purána. The latter speaks of condensation and collocation, but in the passage under reference a Tanmátra is supposed to act as a radicle, as the centre of a system, surrounded or encircled by Tanmátras of the immediately higher order in the medium of its own Bhúta.

Thus an atom of A'kása has the following structure :—



An atom of A'kása

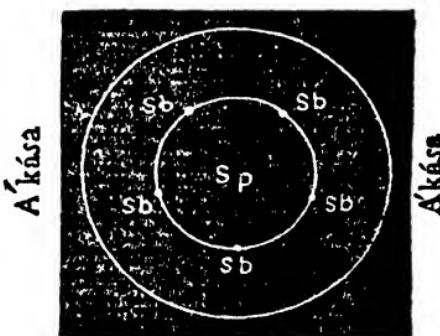
S'b = S'abda-Tanmátra (vibration-potential)

Bh = (Bhútádi)

An atom of Váyu is constituted as follows :—

This takes place within the surrounding medium of A'kasa.

A'kasa



A'kasa

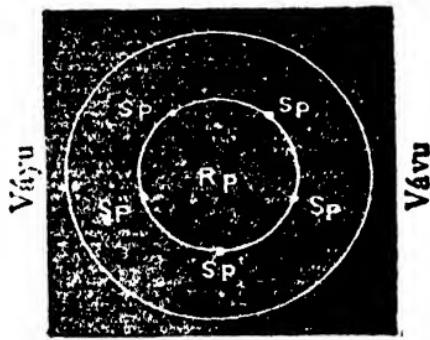
An atom of Váyu

$Sp =$ Sparsa-Tanmátra (impact-potential)

$Sb =$ S'abda-Tanmátra (vibration-potential)

An atom of Tejas—heat-and-light corpuscle—
has the following structure :—

Váyu



Váyu

An atom of Tejas

Rp = Rúpa-Tanmátra (light-potential)

Sp = Sparsa-Tanmátra (impact-potential)

and so on.

A Chemist will be disposed to push his chemical processes into the region of subtle matter. He may translate आवरण as a menstruum, and सहायक as a catalytic agent. In this case, an atom of Váyu will be considered as generated from the impact-Tanmátra as a radicle, in the menstruum of vibration-Tanmátra, with A'kásá-atoms as a catalytic agent.

अत्रायं क्रमः—भूतादेः शब्दतन्मात्रं जायते, शब्दतन्मात्रं भूतादिराहणीति, ततः आकाशं जायते, ततः अक्षात् शब्दतन्मात्राचात् स्वर्गतन्मात्रं जायते, स्वर्गतन्मात्रं शब्दतन्मात्रमाहणीति, एवं शब्दतन्मात्राहतात् आकाशसहायकात् स्वर्गतन्मात्रात् वायुजायते, ततः अक्षात् स्वर्गतन्मात्रात् कृपतन्मात्रं जायते कृपतन्मात्रं स्वर्गतन्मात्रमाहणीति, एवं स्वर्गतन्मात्राचाहतात् वायुसहायकात् कृपतन्मात्रात् तेजो जायते—*and so on.* अयं क्रमः तत्त्वव्यविवरणे कृष्णपादेकलः। वरवरमुनि, तत्त्वव्यवधार्य (अधिक्रमकरण).

A slight variation of the above view is ascribed to a certain school of Vedántists in the तत्त्वनिषेधपञ्च.

The scheme may be represented as follows :—

A Bhúta-atom is evolved by integration (condensation and collocation, सूक्ष्मावस्थारूप) from the corresponding Tanmátra (subtile matter). This is the same view as that of the Vishnu purána,

The Tanmátras again evolve from one another in a lineal series as in Parásara's view. But the process of this generation is somewhat more complex. A Tanmátra first disintegrates and emanates in a surrounding medium (a menstruum) of the Tanmátra just preceding it in the order of genesis and with the help of its own Sthúla Bhúta as a sort of catalytic, generates the Tanmátra next in order : e.g., the infra-atomic impact particles (अर्धतन्त्रात्) disintegrate or emanate, in a surrounding 'atmosphere' of the vibratory subtle matter (चक्षुष्टतन्त्रात्) and then with the help of their own atomic integration Váyu, gas, generate the Tanmátra next in order, the subtle matter of radiant light-and-heat (रेतः).

III. Patañjali's view, as expounded in the व्यासभाष्य and शीघ्रवाचिक is as follows :—

(a) The order of genesis of various forms of subtle matter (potentials) :—

(1) Bhútádi, the rudiment-matter, original Mass, acted on by Rajas, Energy, produces the sound-potential (vibration-potential) अव्याप्तिभूतं चक्षुष्टासामा कार्यवद्ये राजकाहहारः वहकारो चतुरि । .

(2) This subtle vibration-potential, as a radicle, with accretion of rudiment-matter

(Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtile touch-potential (impact-potential) which is impinging as well as vibratory (oscillating).

- (3) This subtile impact-potential again, as a radicle, with accretion of rudiment-matter (Bhútádi) condensing and collocating, and acted on by Rajas, generates the subtile light-and-heat potential (रुद्रावास) which radiates light-and-heat, in addition to being impinging and vibratory.
- (4) Next, the light-and-heat potential, as a radicle, with accretion of rudiment-matter, (Bhútádi) condensing and collocating as before, generates the subtile taste-potential, which is charged with the potential of the taste-energy, and of viscous attraction, in addition to being vibratory, impinging and radiant.
- (5) Lastly, the subtile taste potential as a radicle, with accretion of rudiment-matter as before, condensing and collocating, generates the subtile smell-potential, which is charged with the potential of the smell-energy, and also of cohesive attraction, in addition to being vibratory, impinging and radiant.

The order of genesis of the Bhúta Paramánus (forms of atomic matter).

The five classes of atoms are generated as follows :—

- (1) The sound-potential, subtle matter, with accretion of rudiment-matter (Bhútádi) generates the A'kása-atom.
- (2) The touch-potentials combine with the vibratory particles (sound-potential) to generate the Váyu-atom.
- (3) The light-and-heat potentials combine with touch-potentials and sound-potentials (*i.e.* with impact particles and vibratory particles) to produce the Tejas-atom.
- (4) The taste-potentials combine with light-and-heat potentials, touch-potentials and sound-potentials (*i.e.* with radiant, impingent and vibratory particles) to generate the Ap-atom and
- (5) The smell-potentials combine with the preceding potentials (*i.e.* with particles of taste-energy and with radiant, impingent and vibratory particles) to generate the earth-atom.

The A'k'sa-atom possesses penetrability, the Váyu-atom impact or mechanical pressure, the Tejas-atom, radiant heat-and light, the Ap-atom, viscous attraction, and the Earth-atom, cohesive attraction.

Vijnâna-bhikshu in one passage gives the following scheme of the genesis of the Bhutas :—

A radicle of sound-potential with rudiment-matter gives A'kâsa-atom (Bhútádi), a radicle of touch-potential with A'kâsa-atom gives Vâyu-atom, a radicle of light-and-heat potential with Vâyu-atom gives Tejas-atom, a radicle of taste-potential with Tejas-atom gives Ap-atom, and a radicle of smell-potentials with Ap-atom gives Earth atom. On this view, an atom

of A'kâsa = Bh(Sb)

of Vâyu = { Bh(Sb) } (Sp)

of Tejas = { Bh(Sb) } (Sp) Rp

where Bh = भूतादि, Sb = स्वस्त्रमात्र, Sp = सर्वस्त्रमात्र, Rp = रुपस्त्रमात्र, and so on.

Bhutas and Paramanus—Cosmo-genesis and its successive stages.

The 'five Bhutas' stand for a classification of substances on the basis of their generic properties resulting, as the Sâṅkhyas hold, from the structural type of their constituent atoms—a classification more physical than chemical, or properly speaking chemico-physical, unlike the purely chemical classification of the so-called elements of modern chemistry. A Paramânu, again, is a type of atoms corresponding to each Bhûta class, and indeed one and the same kind of Paramânu may comprehend atoms

of different masses, if only these should agree in their structural type.

Cosmo-genesis—a bird's eye view :—Out of the all-pervasive rudiment-matter (Bhútádi) appeared A'kása (ether), first as a Tanmátra (subtile matter) charged with the potential energy of sound (vibration-potential), and then as an atomic integration of a mono-Tanmátric structure (the A'kása-atom —*आकाशाणि*) also ubiquitous and all-enveloping. In the next stage we find a new kind of Tanmátras, systems of the infra-atomic vibratory particles, so arranged as to manifest a new form of energy, that of impact or mechanical pressure and these Tanmátras (*अर्धतन्मात्राणि*) combining with the vibration-potentials (A'kása Tanmátra) produced a new kind of atom, the di-Tanmátric Váyu-atom, which by aggregation formed a gaseous envelope composed of impinging (driving) vibratory particles (Váyu). Next appeared the third class of Tanmátras, infra-atomic systems of the impinging vibratory particles, which by their collocation developed a new form of Energy—the energy of radiant heat-and-light. These Tanmátras (*स्व-तन्मात्राणि*) combining with the potentials (Tanmátras) of vibration and impact, produced a new kind of atom—the tri-Tanmátric Tejas-atom, the light-and-heat corpuscle, which by aggregation enveloped the gaseous world in huge flames. In the next stage we have the fourth class of

Tanmátras, new and complex infra-atomic systems of the radiant impinging vibratory particles, which evolved the energy of viscous attraction as well as the potential Energy concerned in the taste-stimulus. These Tanmátras (रसतन्मात्राः) combining with the three previous ones, gave rise to another class of atoms, the tetra-Tanmátric Ap-atom, and the flaming gases were thus precipitated into cosmic masses of viscous fluid matters (Ap). Finally appeared the fifth class of Tanmátras infra-atomic systems of the viscous radiant impinging vibratory particles which developed new forms of Energy—the Energy of cohesive attraction, as well as the potential energy concerned in the stimulus of smell. These Tanmátras (गन्धतन्मात्राः) uniting with the other four kinds or infra-atomic subtle particles, formed another class of atoms, the penta-Tanmátric Earth-atom. Thus the viscous fluid matters were condensed and transformed into the Earth-Bhúta, comprising the majority of the so-called elements of chemistry.

The Puráñas, in their own fanciful way, conceive that, in the course of cosmic evolution, each succeeding Bhúta appeared within an outer envelope of its immediate predecessor, with a total mass (or volume ?) a tenth less than that of the latter.

विष्ट तत्वाये कदैश्च गती वायुः प्रकल्पितः ।
 चिक्षयैत् बङ्गमप्येवं सहस्रो न्यूनवत्सिमं ॥
 त्रिशास्त्रावरचेष्ये वा न्यूनाचिक्ष-विचारणा ।
 वायोद्दृश्याशतो न्यूनो बङ्गवर्यो प्रकल्पितः ॥
 पुराणीकां तारतम्यं दशाश्चेमूलपञ्चके ॥

(पञ्चदशी-भूतविदेश, slokas 72, 81 and 82)

Examples of the different Bhútas :—

1. A'kása :— This is ubiquitous.
2. Váyu :— Various substances composed of di-Tanmátric atoms,—kinds of Váyu—must have been formed in the gaseous envelope in the second stage of cosmic evolution, out of the proto-atoms of A'kása. But they have either suffered a fresh transformation into substances of a more complex atomic structure, or have dissipated into the mono-Tanmátric A'kása, out of which they took their rise. The one familiar example now surviving is atmospheric air. Water-vapour (वाष्प) is but water (Ap), and smoke, fumes, etc. but earth-particles in gaseous diffusion.
3. Tejas .— Various classes of Tejas corpuscles,—substances with tri-Tanmátric atomic structure, i.e. two grades subtler

than the ordinary elements of chemistry (which are of a penta-Tanmátric structure),—are even now known. (तेजी भौमादि-
भेदेन वडुविधः । भौमं दिव्यं औदये आकरणं—
वरवरमुनि,—तत्त्ववद्यभाष्य) ।

First, there is fire, or the light-and-heat emitted by the burning log of wood or lamp (अग्निः—दीपः—
भौमं तेजः). Now it is important to note that the flame of a burning log of wood (इन्द्रज) or an oil-lamp is not pure Tejas, a pure mass of light-and-heat corpuscles. There is chemical union with Earth-particles (particles of the hard penta-Tanmátric substance) acted on by Energy ; and then the Tejas corpuscles, light-and-heat particles which are latent (absorbed) therein, come forth as flame (पार्थिवोपद्वेष्ट तदनुगतात् तेजसः अधिभेदति—
विज्ञानभिज्ञु—प्रवचनभाष्य. Sútra 110, Chap. V). Then there is the light of the sun and the stars (दिव्यं सौरं चादित्यादि) which are flaming masses of molten viscous matters (जलमादेष्वमं तेजः दिव्यं तत्त्वं
सूर्यादि,—तत्त्ववद्यभाष्य, अचित्प्रकरण) or of molten earthy matters सूर्यादीनि सूर्यादि तेजासि पार्थिवद्वय-
सुषेनैव अवस्थितानि,—विज्ञानभिज्ञु, प्रवचनभाष्य, Sútra 13,
Chap. III). There is also the lightning, which liberates a kind of Tejas latent in the aqueous particles and vapours, under the action of

Energy, in the same way as an ordinary fire liberates the Tejas latent in the wood or other fuel. Next there are the stores of animal heat derived from the break-up of the nutritive material (जीवद्यं). Lastly there comes the peculiar form of the Tejas Energy (radiant Energy) stored up in the metalliferous ores and igneous rocks which have been formed in the subterranean heat. Here Earthy matters are mixed up, but the radiant Energy predominates in the composition of the metals (तेजसाधिक्येन तेजसादिता सुवर्णादोषः—विज्ञान-निष्ठ, प्रथमभाग, Sútra 19, Chap. III). Aniruddha, a late Sáñkhya commentator, notes in reference to 'igneous bodies' that the greater part of their mass is derived from the Earth-Bhúta, though the Tejas particles determine the peculiar chemical combination, which produces them ; and this must also be his view of the composition of the metals.

तत्र चपि (तेजसे भरीते चपि) वडुतरपार्थिवावयवावटचकल॑, चप्पले चातुपभोगात् । (चनिरुद्धठति—Sútra 112, Chap. V.)

4. Ap. This viscous fluid of a tetra-Tanmátric structure has but one pure example, viz., water, though the various organic acids, the juices of fruits and the saps of plants, are supposed to be transformations of watery radicles combined with different kinds of earthy accretions.

5. Lastly the Earth-Bhúta, the hard full-formed matter, with its penta-Tanmátric atoms, comprises by far the majority of the so-called chemical elements.

The question is,—how does one and the same Bhúta, of the same formal structure, comprise different kinds of elements, with different atomic masses, and different characteristic properties? And the answer is not far to seek. The properties of a thing are only the energies that are manifested in the particular collocations of the three Gunas,—Mass, Energy and Essence; and a tri-Tanmátric, or a penta-Tanmátric atom, *i. e.* an atom composed of three or of five kinds of Tanmátras may differ from another of the same class, in respect of the number of constituent Tanmátras of any particular kind, as also of their collocation or grouping, and therefore in mass as well as in generic and specific characters.

The Sánkhyā-Pátañjala conceives the properties (or energies) of substances to result from the grouping or the quanta of the Tanmátras, or the Gunas themselves, and hence any radical differences in substances of the same Bhúta class must characterise their atoms, though in an infra-sensible form. In the Nyáya-Vaisesika, on the other hand, the atoms of the same Bhúta class are alike in themselves, homogeneous; and the

variety of substances comprehended under the same Bhúta, is ascribed merely to the different arrangements or groupings of the atoms (अट्ट) and not of their components, for components they have none.

As a typical and familiar instance of the variety of characteristic properties (or energies) that may result from variations in accompaniment or grouping, the Sánkhyá-Pátañjala points to the various kinds of fruit acids and juices, all originating from one and the same Bhúta (water) with different accretions of earthy matters (भूतकारः). In the same way, though we speak of only five classes of Tanmátras and atoms, the infinite variety of the world results from the infinitely varied collocations of the three original Guṇas, which underlie Tanmátra and atom alike (सत्त्वरजसमस्ता अपकर्षकाहापदः: संघातः परमाणुरिति—व्यायवासिक, उद्धीतकर, reporting the Sánkhyá view : अयुतसिद्धाबयवः: संघातः परमाणुरिति—व्यासभाष्य, Sútra 44, Pada III.—परमाणुः सामान्यविशेषात्मा अयुतसिद्धाबयवभेदात्रुगतः: समुदाय.—व्यासभाष्य, Sútra 44, Pada IV,—योग्यतार्वाच्छ्राच्छ्रिणः शक्तिरेत् चर्चः (ibid., Sútra 14, Pada III.) यी चर्चंतु अनुपाती सामान्यविशेषात्मा सीड्यशी चर्चाँ (ibid., Sútra 14, Pada III.).

स्थादेतत—कथं एकहपाणी गुणानां अनेकहपा प्रहितः—
इत्यत आह परिणामतः सलिलवत्। यथा वारिद्विमुक्तं उद्दर्कं
एकहपे आपि तत्त्वाविकाशम् वासाध वारिकेत्व-तात्त्वी-वित्त्।

चिरविल्ल-तिस्तुकामस्तक-कपिलवक्षरसतया परिषामात् नमुराक्षस्तक-
तिस्तुकटुकवाचतया विकल्पते, एवमेकोक्तगुणसम्भात् प्रधानं गुणम् आश्वित
अप्रधानगुणः परिषामभेदात् प्रवर्णयन्ति । तदिदमुक्तं प्रतिपत्तिगुणवाचतय-
विशेषात्, एकोक्तगुणाकृतये यो विशेषसम्भात् इत्यर्थः ।

(वाचस्पति—क्षीमुदी—On Káriká 16.)

If we take a unit of rudiment-matter (Bhútádi) for the unit of mass (cf. the mass of an electron with a charge of motion etc.), and represent the first Tanmátra by t_1 such units, and if further, t_2 , t_3 , t_4 , t_5 units of mass (Bhútádi) be successively added at each accretion to form a fresh Tanmátra, then the second, third, fourth and fifth Tanmátras will respectively contain $t_1 + t_2$, $t_1 + t_2 + t_3$, $t_1 + t_2 + t_3 + t_4$, and $t_1 + t_2 + t_3 + t_4 + t_5$ units of mass.

Also the Váyu atom (bi-Tanmátric system) will contain $t_1 + (t_1 + t_2)$, i.e. $2t_1 + t_2$ units of mass ; the Tejas-atom (tri-Tanmátric system) will contain $t_1 + (t_1 + t_2) + (t_1 + t_2 + t_3)$ i.e. $3t_1 + 2t_2 + t_3$ units ; the Ap-atom (tetra-Tanmátric system) $t_1 + (t_1 + t_2) + (t_1 + t_2 + t_3) + (t_1 + t_2 + t_3 + t_4)$, i.e. $4t_1 + 3t_2 + 2t_3 + t_4$ units ; and the Earth-atom (penta-Tanmátric system), $t_1 + (t_1 + t_2) + \dots + (t_1 + t_2 + t_3 + t_4 + t_5)$, i.e. $5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5$ units.

If t units of mass be added to the first Tanmátra to form the atom of A'kása, the latter will contain $t_1 + t$ units of mass.

In other words the numbers representing the mass-units (Tamas) in the different classes of atoms (gross matter) will form an ascending series, viz. $t_1 + t$, $2t_1 + t_2$, $3t_1 + 2t_2 + t_3$, $4t_1 + 3t_2 + 2t_3 + t_4$, and $5t_1 + 4t_2 + 3t_3 + 2t_4 + t_5$.

Now if a follower of the Sāñkhyā-Pātañjala were asked to account for differences among Paramāṇus of the same Bhūta class, he would perhaps suppose t_1 to vary from α_1 to β_1 , t_2 from α_2 to β_2 , t_3 from α_3 to β_3 , t_4 from α_4 to β_4 and t_5 from α_5 to β_5 .

Therefore the mass-units contained in the Vāyu-atoms of the different possible Vāyu substances would be represented by $2\alpha_1 + t$, $2\alpha_1 + 1 + t$, $2\alpha_1 + 2 + t$,..... $2\beta_1 + t$, in A. P. with unity as common difference, there being $2(\beta_1 - \alpha_1) + 1$ possible Vāyu substances.

The mass-units contained in the Tejas-atoms of the different possible Tejas substances would be represented by the series, $3\alpha_3 + 2\alpha_2 + \alpha_3$, $3\alpha_1 + 2\alpha_2 + \alpha_3 + 1$,..... $3\beta_1 + 2\beta_2 + \beta_3$, increasing in A. P. by unity as common difference, then being $3(\beta_1 - \alpha_3) + 2(\beta_2 - \alpha_2) + (\beta_3 - \alpha_3) + 1$, Tejas substances possible.

The mass-units contained in the Ap-atoms of the different possible Ap-substances would form the series $4\alpha_1 + 3\alpha_2 + 2\alpha_3 + \alpha_4$, $4\alpha_1 + 3\alpha_2 + 2\alpha_3 + \alpha_4 + 1$,..... $4\beta_1 + 3\beta_2 + 2\beta_3 + \beta_4$, there being $4(\beta_1 - \alpha_1) + 3(\beta_2 - \alpha_2) + 2(\beta_3 - \alpha_3) + (\beta_4 - \alpha_4) + 1$ Ap-substances possible.

The mass units contained in the Earth-atoms of the different possible Earth-substances would form the series in A. P., $5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5$, $5\alpha_1 + 4\alpha_2 + 3\alpha_3 + 2\alpha_4 + \alpha_5 + 1, \dots, 5\beta_1 + 4\beta_2 + 3\beta_3 + 2\beta_4 + \beta_5$, there being $5(\beta_1 - \alpha_1) + 4(\beta_2 - \alpha_2) + 3(\beta_3 - \alpha_3) + 2(\beta_4 - \alpha_4) + (\beta_5 - \alpha_5) + 1$ Earth-substances possible.

Size (परिमाण).—As to size or volume, the Sánkhyá accepts only two kinds,—the infinitesimal, which is also without parts (अणु—निरक्षय) and the non-infinitesimal, which consists of parts (महत्—साक्षय). The latter varies from the excessively small (the so-called Anus. Tanmátras and Paramá-nus) to the indefinitely great (परममहत्—विभु,—e.g.—A'kása).

The Gunas alone are infinitesimal, with the exception of those ubiquitous ones that evolve into A'kúsa-atoms and Mind-stuff (चाकाशाणु and चलःकरण) :—all the rest of the evolved products (whether subtle or gross matter) are non-infinitesimal.

Vijñánabhikshu notes that all the Gunas (Reals) cannot be ubiquitous. If this were the case, that disturbance of equilibrium, that unequal aggregation with unequal stress and strain, with which cosmic evolution begins, would be impossible. The Gunas, which give rise to A'kása and Mind-stuff, must be held to be ubiquitous, and this will suffice for the ubiquity of Prakriti,

(न च चक्राहम्बने गुणास्यपक्षते: विभूतसेवावदव्यते इति वाच्म् ।
अतःकरताकाशहेतुगुणान् विभूतेन तदुपपत्तेः । सर्वंगुणान् विभूते
सति चाद्यपरिचामहेतुचीभसंशोगाद्यसंभवात् (बोगवार्त्तिक, Sútra 51,
Pada III.) .

Chemical analysis and Synthesis—Elements and Compounds.

What then is the equivalent in the Sánkhyá-Pátañjala of the distinction between a chemical element and a chemical compound, or is there none? Did or did not this elaborate physical analysis and classification of things lead on to a classification based on chemical analysis and chemical synthesis? These are questions of singular interest, the answer to which will disclose some new points of view from which the ancient Hindu thinkers approached the problems of chemical physics and physical chemistry.

Aggregates (समृष्टाः) may, in regard to their structure, be divided into two classes, (1) those of which the parts are in intimate union and fusion, being lost in the whole (अयुक्तिश्वादयवाः समृष्टाः) ; and (2) mechanical aggregates, or collocations of distinct and independent parts (उक्तिश्वादयवाः समृष्टाः).

A substance is an aggregate of the former kind, and may be divided into two classes, (1) the Bhútas and their 'isomeric' modifications भूत, भूतमेद and भूतविकार) ; and (2) chemical compounds (जितितद्वय,

संकरभूताद्य). Chemical compounds again may be subdivided into two classes, (1) those composed of atoms of the same Bhúta class, i.e. of different isomeric modifications of the same Bhúta, and (2) those composed of atoms of different Bhúta classes. In the first case, there is contact between 'isomeric' atoms (समातीय-संयोग), in the second case, between heterogeneous or 'polymeric' ? atoms (विजातीय-संयोग). The first contact leads to intimate union (सङ्गः—सङ्गात्मः यः संयोगविजेयः तेजस इव्याप्ता विकारो भवति—विजातमिहु प्रवचनभाष्य) : the isomeric atoms by a peculiar liberation of Energy (समातीयोपदात्र—the action of similars on similars) are attracted towards one another, and being riveted as it were, form the so-called material cause (उपादान कारण) of the compound product. The second kind of contact (that between unlike or 'polymeric' ? atoms of heterogeneous Bhútas) begins with a liberation of Energy (उपदात्र), which breaks up each of the Bhútas, and taking particles (or atoms) of one as nuclei or radicles groups particles of the rest round these radicles in a comparatively free or unattached condition. In this case, one Bhúta, that which serves to furnish the radicles, not necessarily that which is numerically or quantitatively predominant, gets the name of material cause (उपादानकारण), and the others, which by their collocation cause the liberation of Energy (उपदात्र, उपदात्र or विद्युत).

are called efficient causes (मिनित कारण) — एवं मेकैक-
गुणसम्भवात् प्रथान् गुणमात्रित्वं अप्रधानगुणाः परिचामभेदान्
प्रवर्तयन्ति—वाचस्यति, कौमुदी on Kárika 16. The illus-
tration given (viz. the Rasas as modifications of
Ap, water, with Earth-accretions) show that this
process applies not only to the Gunas, but also to
the Bhútas. यथा आकाशादिकरं सहितं पतितं जागाङ्गपात्
संश्लेषात् भिषते—(गौडपाद on Káriká 17).—तत्र चपि (तेजसे
शरीरे चपि) बहुतरपार्थिवावयवावृथात् इत्यत्वे च अनुपभोगात् (अनिदृत
on Sútra 112, Chap. V), जातिसाहचर्यस्य अस्ताक्षमदीषत्वात्
सामयोसमवधाने अनेकैरपि इन्द्रियैः एकदा एकठञ्चुपादने वाधकं नाशि
(विज्ञानभिषु—प्रवचनभाष्य).

Aniruddha goes so far as to hold that both
'isomeric' and 'polymeric' (or 'heterogenic') com-
binations are real cases of constitutive contact,
(आरक्षकसंयोग, e.g. जीतिकवायोदेहारक्षकलम्—अनिदृत on Sútra
113, Chap. V.) But in the later Sánkhya-Pátañjala
the current teaching denied this—बह्वनामुपादानातोगात्
(Sútra 102, Chap V), when विज्ञानभिषु notes—बह्वनां
भिज्ञातोयानां चोपादानलं न हृषिति सज्जातोयमेवोपादानम् । इतरतः
सूत्वचतुष्टवमुपदर्शकम् ।

But besides these transformations of substance
(द्रव्याकर-परिचाम) by 'isomeric' or 'heterogenic'
process, ceaseless changes go on in the characters,
the modality, and the states of substances—changes

which are due to the unequal distribution of force (or of stress and strain,—pressure) among the Gunas, which are in themselves constant.. (धर्म-खण्डवस्त्रापरिचयानाः न इत्याकारतः,—यथा एका रेखा ग्रन्थाने अते दग्धस्याने दग्ध, एकचैकस्याने, यथा चैकत्वेऽपि स्त्री लाता चीचते दुहिता च खसा चंति,—गुणिनिवलेऽपि गुण, न विमर्शेचिद्वात्—व्यासभाष्य, Sútra 13, Pada III.)

“Even as the same figure ‘1’ stands for a hundred in the place of hundred, for ten in the place of ten, and for a unit in the place of unit.”*

* This conclusively proves that the decimal notation was familiar to the Hindus when the Vyása-Bháshya was written, i.e. centuries before the first appearance of the notation in the writings of the Arabs or the Greco-Syrian intermediaries. Váchaspati, who comments on the Vyása-Bháshya, composed his Nyáya-Súchí-Nibandha in वस्त्रावस्त्रकरी i.e. Samvat 898 or 842 A. D. This cannot be S'aka 898, for apart from the decisive use of वस्त्र, which by this time had come to signify the Samvat era, Váchaspati's commentator Udayana, wrote the Lakshanávali in S'aka 906—

तर्काभ्यराहप्रमितेष्वतीतेषु शकाकालः ।
वर्णदृदयगच्छे सुवोधा खण्डवस्त्रम् ॥

and Udayana, who wrote the Parisuddhi on the Tátparyatáská of Váchaspati, could not have been a contemporary of the latter, as will also appear from the invocation to Sarasvati in the opening lines of the Parisuddhi. Váchaspati then preceded Udayana by 142 years, and must have been himself preceded by the author of the Vyása-Bháshya by a

Now the question is—in these mixed substances does the fusion take place by Paramánu or by larger masses (or lumps)? Now a Paramánu is defined to be the smallest portion of any substance which exhibits the characteristic qualities of that substance,—in other words, it stands for the smallest homogeneous portion of any substance. It is not without parts and therefore not indivisible. It is subject to disintegration. In a Bhúta or its isomeric modification, the Paramánu, the smallest homogeneous component particle, is unmixed, and therefore corresponds to the atom of modern chemistry. In a mixed substance (मिलितद्रव्य, संयुक्तभूताण्ड) whether it is an 'isomeric' or a 'polymeric' compound, the qualities are due to the mixture, and therefore its Paramánu, the smallest homogeneous particle possessing its characteristic qualities, must result from the mixture of the Paramánu (in smaller or larger numbers as the case may be) of the component substances. The Para-

longer interval still, for Váchaspati ascribes the Bháshya to Veda-Vyása himself (वेदव्यासेन भाषिते भाष्ये व्याख्या विभासते). The internal evidence also points to the conclusion that the Bháshya cannot have been composed later than the sixth century,—cf. the quotations from Pañcasikha, Várhaganyás, and the Shashti-Tantra-Sástra, without a single reference to I'svara-Krishna—which is decisive. I may add that I remember to have come across passages of a similar import in Buddhist and other writings of a still earlier date.

mánu of a mixed substance therefore corresponds to what we now call molecule. (अपकर्त्तपर्यन्तं इत्यं परमाणुरिति—व्यासभाष्य । लोहस्य हि प्रविभज्यमानस्य यजित्रवदयते अस्तत्वारतम्यं व्यवतिष्ठते सः अपकर्त्तपर्यन्तपरमाणुः—वाचस्पति—तत्त्ववैशारदी—Sútra 52, Pada III.—नाणुगित्यता न निर्मागत्वं । पृथिवीपरमाणुः जलपरमाणुरित्यादित्यवहारस्य पृथिव्यादीनामपकर्त्तकाणां भिन्नायेच । विज्ञानमित्यु—प्रवचनभाष्य, Sútra 88, Chap. V.)—That the Paramánus form molecules (इषुक) in forming substances, is acknowledged by the Sāñkhyas as will appear from Gaudapáda,—तथा चन्द्रोन्याशयाच इषुकवदगुणाः । (गौडपाद, on Káriká 12). Even the Vaïseshikas, with their prejudice against ‘polymeric’ or ‘heterogenic’ combination, acknowledge that in ‘polymeric’ compounds the different Bhúta substances unite by their Paramánus (or atoms), though they rigidly insist that in such cases only one atom should be regarded as the ‘radicle’ (उपादान or इत्यारथकारण) and the others as co-efficient causes (निमित्तकारण—उपटकारण), e.g. प्रश्नपाद—एवं समुत्पन्नेत्रु चतुर्षु नहासूतेत्रु नहेऽरजाभिज्ञानमाचात् तेजसीभीऽच्छुभ्यः पार्थिवपरमाणुरुहितेभी नहहस्य मुख्यतये (प्रश्नपादभाष्य—where S'rádbara notes पार्थिवा चरयता उपटकारणः and Udayana तेजसानां परमाणुनां पार्थिवाणुरुहितेन चक्षुरुहितकारणं चिह्नितं) ।

It is only in the mediæval Sāṅkhya-Pātañjala that under the influence of the Nyāya-Vaisesika doctrine a radical difference was conceived to exist between the structure (or constitution) of a molecule composed of 'isomeric' atoms, and that of one composed of heterogeneous (or 'polymeric') atoms. In the former case, there was believed to take place intimate union (सङ्ग), in the latter case, only a grouping of comparatively free or loosely attached atoms round a radicle atom (मुहूर्त), with liberation of Energy (उपदण्ड,—चक्रदण्ड—or विद्युत) and the setting up of unequal stress and strain (गुच्छवेष्टयविमर्श—ईन्द्रजलाच). At the same time, it was of course admitted that this distinction does not apply to the forms of subtle matter (Tanmátra—सूक्ष्ममूर्त) which could unite in intimate fusion, whether homogeneous or heterogeneous. For example, the subtle body (सूक्ष्मशरीर) which is supposed to be the seat or vehicle of the conscious principle is acknowledged by Vijnána-bhikshu to be penta-Bhautic (पञ्चमूर्तात्मक); in other words, all the five Tanmátras serve as material causes, though the gross body (the animal organism) is stated to be only a 'polymeric' compound with the Earth-Bhúta as radicle or base. चधिहानशरीरं च सूक्ष्मं पञ्चमूर्तात्मकं वस्त्रते । दक्षादक्षार्थं यत् शूतपञ्चकं लिङ्गाधिहानं शरीरम् (प्रवचनमात्र—Sútras

11 and 12, Chap. III.—स्फुलशरीरं पार्थिवमेव अन्वानि च
भूतानि उपदध्यकाणि (*ibid.* Sútra 19, Chap. III.)

But in the original Sáñkhyá-Pátañjala it appears that the production of a new substance by mixture of unlike Bhútas (विज्ञातीयसंयोग) was conceded as freely as in the Vedánta, and was conceived as nowise differing from the formation of a compound of atoms of the same Bhúta class. The Sáñkhyá analysis of all change into transformations of Energy due to collocations of unchanging Gunas, in other words, the prevailing chemico-physical (or physical) point of view, naturally recognises no distinction between collocations of 'isomeric' and those of heterogeneous (or 'polymeric' ?) atoms. At bottom they are all collocations of the Gunas. Even Vijñánabhikshu who, as one of the latest expounders of the Sáñkhyá-Pátañjala, has been most affected by the Vaisesika prejudice against 'polymeric' combination (विज्ञातीयसंयोग) urges that the qualities of a compound substance are not necessarily the result of similar qualities in the component elements. (सज्ञातीय-कारणगुणस्यैव कार्यगुणारञ्जकता इति तु त्रिष्ठा (तार्किकाणां) अपि न नियमः ।) Elsewhere he explains that far from the vital activity being independent it is originated and maintained by the combined operation or fusion of the different sensory and motor reflexes of the living

organism, and notes that the united operation of mixed (or miscellaneous) causes, where there is a fit collocation of matter, offers no difficulty to a follower of the Sánkhyá-Pátañjala :—(जातिसार्थ्यस्य चक्राकमदी-
चत्वात्, सामयीसमवधाने सति अनेकैरपि इन्द्रियैः एकदा एकडस्तुत्-
पादने वाधकं नालि—प्रवचनभाष्य, Sútra 32, Chap. II). In the
middle of the ninth century, we find Váchaspati
instancing some 'heterogenic' or 'polymeric' composi-
tions as typical examples of evolutionary change
(परिणाम) and unhesitatingly accepting the substan-
tive character of the products. In the Kaumudí he
describes the various acids and juices of fruits as
modifications of the same original water in the pre-
sence of different kinds of earthy accretions. The
process is peculiar. The water-particle (or atom)
serves as a radicle or centre of a system, and the diffe-
rent kinds of the Earth-Bhúta centering round this
as a nucleus become the seat of forces, which bring
in the development of new energies (and new qual-
ties, e.g. tastes) in the water. यथा वारिद्विमुक्तमुदकं
एकारसमपि तत्त्व-भूतविकारात् आसाद्य नारिकेल-ताळी-बिल-कपित्वादि-
रसतया परिणामात् मधुराक्लजवश्चतिक्रकटुकवायतया विकल्पते । इति
एवेक्षण्यसम्भवात् प्रधानगुणस्म् आश्रित्य अप्रधानगुणाः परिणामभेदान्
प्रवर्त्यन्ति । (कीमुदी on Káriká 16). Váchaspati also
points out that different substances may be
transformed into one and the same substance (e. g.

the production of salt by the cow, the horse, the buffalo and the elephant, thrown into the salt factory of Sambara in Rajputana or of the flame of a candle by the combination of wick, oil and fire. (परिषामेकत्वं बहुमासपि एवः परिषामः दृष्टः । तदयथा गवाऽन्न-
मङ्गिषमातङ्गः नां रुमानिक्षिपानां एकलवण्यतजातीयस्त्रियः परिषामः,
बर्षिदेलानखानां च प्रदीप इति ।—तत्त्ववेशारदो on व्यासभाष्य, Pada
IV. Sútra 14.)

Earlier still, *i.e.*, not later than the sixth century, the Vyása-Bháshya, noting that inorganic matter, vegetable substances and animal substances do not differ from one another essentially in respect of their potential energies and ultimate constituents, points out that various bi-Bhautic chemical compounds of water and earth substances, in the shape of saps, acids and juices, are found in plants in their different parts (जलभूम्योः पारिषामिकं रसादिवैश्वर्यं स्थावरेषु दृष्टम्). In other words, bi-Bhautic compounds are here placed in the same category as 'isomeric' compounds of substances of the same Bhúta class, for here the particles of both the Bhútas are regarded as forming the matter (material cause—उपादानकारण) of the smallest homogeneous portions of the compound substances.

N.B.—Váchaspati naturally interprets this to mean separate modifications of the two Bhútas.

The view of the earlier Sāñkhyas that atoms of different Bhūtas may chemically combine to form molecules of compound substances as much as atoms of different modes of the same Bhūta comes out clearly in Utpala's brief reference to the Sāñkhya system in his commentary on Varahamihira's Vṛihat Samhitā. (एभः पञ्चमः [तत्त्वादेभः] पञ्चमहाभूतानि भवन्ति । तेभः श्रौरिणा श्रौरात्रि । यतः पञ्चमहाभूतमयाणि श्रौरात्रि Utpala, Chap. I, S'loka 7).

Chemistry in the medical schools of ancient India :—As a matter of fact, long before the fifth century, probably as early as the first century A. D., the prevailing schools of medicine and surgery which were based on the Sāñkhya teaching with a methodology derived from the Nyāya-Vaisesika doctrine (cf. Charaka, S'árirásthána, Chap. I, Vimánasthána, Chap. VIII—also Susruta, S'árirásthána, Chap. I) had founded an elaborate theory of inorganic and organic compounds, which equally admitted iso-Bhautic and hetero-Bhautic combinations. Like the Vedantists, Charaka held that each of the gross Bhūtas (Mahábhūtas) is a peculiar ultra-chemical compound of five original subtle Bhūtas. In this sense, every substance is penta Bhautic, but for purposes of chemical analysis and synthesis, i. e. considered with reference to the Mahábhūtas, all substances in their chemical constitution, belong to

one or other of the following classes : Mono-Bhautic, bi-Bhautic, tri-Bhautic, tetra-Bhautic, and penta-Bhautic. Compounds of different Bhútas, again, may combine to form more complex substances, and these in their turn, higher compounds still, and so on in progressive transformation, as is more specially the case with organic substances and products.

Physical characters of the Bhútas :— The prevailing physical characters of the different Bhútas and their isomeric modes are enumerated as follows.

Earth-substances—Heavy, rough, hard, inert, dense, opaque, exciting the sense of smell.

Aप-substances—Liquid, viscous, cold, soft, slippery, fluid, exciting the sense of taste.

Tejas-substances—Hot, penetrative, subtle, light, dry, clear, rarefied, and luminous.

Váyu-substances—Light, cold, dry, transparent, rarefied, impinging.

A'kása-substances—Imponderable (or light), rarefied, elastic, capable of sound (vibrations).

(बुद्धारकठिनमन्दस्त्रिराविषदसाम्भ-सूक्ष्मग्रन्थगुच्छतुक्षानि पार्श्विकानि । द्रवजित्यश्वीतमन्दवदुपित्तिचरस्तुक्षतुक्षानि राज्ञानि । उष्ट्रतीक्ष्णतुक्ष-वच्चुत्तुक्षविषदक्षयतुक्षतुक्षानि चाहे वानि । लक्ष्मीत्तरक्षरविषदतुक्षान्म-

गुणवहुतानि वायव्यानि । महुत्तमुपाद्यक्षाश्चन्द्रगुणवहुतानि आकाशात्म-
कान् ।—Charaka, Sárárásthána, Chap. 26 ; compare
Susruta, Sútrasthána, Chap. 41).

Charaka points out that the primary qualities or specific physical characters of the five Bhútas are tactile qualities, *i. e.* sensible to touch, *e. g.* hardness (or roughness) for Earth, liquidity (or yielding to pressure) for Ap, impelling or moving force (pressure) for Váyu, heat for Tejas, and Vacuum (non-resistance, penetrability) for A'kasa.

(खरद्रवच्छोषात् भूजलानिलसेजसाम्,
आकाशस्याप्रतीचासी हृष्टं लिङ्गं धथाकमम् ।
लक्षणं सर्वमेवतत् स्वर्णवेन्द्रियगोचरम् ।

Charaka-Sárárásthána, Chap. I.)

(cf. the elaborate enumeration of physical characters quoted in Vijñána-bhikshu, Yoga-Vártika, Sutra 42, Pada I;—also Varavara's commentary on Tattva-traya Achit-prakarana).

The Mahá-Bhútas—mechanical mixtures:—Susruta notes that each of the gross Bhútas (Mahá-bhútas) is found mixed up with the other Bhútas;—*e. g.*, the Mahábhúta A'kasa is the receptacle (or vehicle) of air, heat-and-light, and water vapour; the Mahábhúta Váyu, of water-vapour, light-and heat, and even fine particles of Earth held in suspension; the Mahábhúta Tejas, of earth-particles in the shape of smoke, and also water-vapour.

(अस्त्रोऽन्वागुपविष्टानि सर्वाव्येतानि निर्दिष्टे—Susruta, Sárásthána, Chap. I.) अन्ये पुनः अन्यथा व्याचक्षते। आकाशे पदम्-दहन-सीयानि। वायौ तेजोऽन्वग्नौ। भूरपि अण्टाविशेषं। भूमिरपि भूमादिकपेत् तेजसि। तेजोद्रव्ये पानीयमपि।—Dalvana on Susruta, loc. cit.)

Mono-Bhautic Earth-substances :—Charaka and Susruta regard the following as Earth-substances—Gold, the five Lohas (silver, copper, lead, iron and tin) and their 'rust', arsenic, orpiment, various mineral earths and salts, sand, precious stones. (Charaka, Sústrasthána, Chap. I. Cf. also Susruta, Sústrasthána, Chap. I—पाणियाः सुवर्णरजतमणिमुक्तामगः—शिलाघ्नकपाखादयः। सुवर्णस्य इह पार्थिवत्वमेवाङ्गीक्रियते गुहलकाठिन्य-स्येव्यादिहेतुभिः। सूक्ष्म आदियहणात् लोहमलसिकमासुधाहर्तालखवच-गैरिकरसाच्चन प्रवृत्तीना—Dalvana on Susruta, loc. cit.)

The salts include common salt, saltpetre, etc. Susruta mentions, the alkalis, borax, natron, Yavakshára (carbonate of potash) etc. The Audbhida salt, an inflorescence of the soil, stands for *reh* (औहिदं पापुखर्षं यज्ञातंभूमितः स्यम्).

Of these Earth-substances, some were known to be compounds, e. g. the chemical salts of the metals, collyrium etc. Susruta describes the preparation of the metallic salts. The leaves of the metals were pasted over with the salts, and then roasted (चयक्षति) (Chikitsásthána, Chap. 10). These metallic salts are therefore mono-Bhautic Earth-compounds. Susruta also gives the preparation of mild and caustic alkalis. (Sústrasthána, Chap. 11.

Origin of precious stones :—Some hazarded the guess that the precious stones are rocks (or earths) metamorphosed by natural process in the course of ages (Varáhamihira—वैरामिहिरः प्राहुदपत्रानाम् कैचित् भूतः स्वभावात्—Utpala notes, —रबद्धपत्रं प्राप्ताः कालान्तरैषः).

Ap-substances, simple and compound :—

Susruta, following Charaka, enumerates various classes of Ap substances (द्रवद्रव्यः) as follows :—waters, acids, milks, curds, butters, oils (vegetable as well as animal), fats, honeys, molasses, alcoholic liquors, urines etc.

Pure Ap (Mahábhúta) is tasteless and the six tastes are developed when the Mahábhúta Ap enters into combination, mechanical or chemical, with other Mahábhútas. Susruta notes that various kinds of Earths are dissolved in the waters of different localities, and where the particles so dissolved are predominantly Earthy, the water tastes acid or salt,—where predominantly watery, the resulting taste is sweet,—where the Earth particles are mixed up with Tejas, the water tastes pungent or bitter etc. Such is the case with mechanical mixtures. In the case of bi-Bhautic or tri-Bhautic compounds Charaka mentions that substances with Mahábhúta Ap predominating in their composition taste sweet; with Mahábhútas Earth and Tejas predominating, acid; with Mahábhútas Ap and Tejas predominating, salt; with Mahábhútas Váyu and Tejas predominating, pun-

gent ; with Mahábhútas Váyu and Akása predominating, bitter ; and with Mahábhútas Váyu and Earth predominating, astringent (Charaka, Sústrasthána, Chap. 26,—cf. Susruta, Sústrasthána, Chap. 42).

In fact with the exception of Susruta's waters which are mechanical mixtures, or rather solutions, all these Ap-substances are organic products and, as such, penta-Bhautic, i. e. compounded of all the five Mahábhútas, and the particular 'taste' which is developed depends on the relative proportion of the Mahábhútas, and the predominance of one or more of them in the penta-Bhautic compound in question.

Qualities of Compouuds.—The isomeric modes of each Mahábhúta have specific colours, tastes etc. due to their structure, i.e. the arrangement of their atoms, and the physico-chemical characters of compounds whether of the same or of different Mahábhútas result from the collocation in unequal proportion of the different forces latent in the atoms of the component substances. Charaka adds that the varied forms (textures) and colours of organic substances, whether vegetable or animal, are derived in the same way.
 एषमेतेषां रसानां वट्टलमुपपत्तं च्युग्मातिरिक्षविशेषात् नहाभूतानाम् ।
 भूतानामिव ज्ञायरज्ञानानां नानावर्णाङ्गतिविशेषाः ।

Susruta ignores Charaka's distinction between Mahábhúta and subtile Bhúta, and views every

substance as in reality penta-Bhautic and it is only the relative predominance of a particular Bhúta or Bhútas in any substance that determines its class. (पृथिव्यसेजीवायुकाशाना समुदायात् द्रव्याभिनिःस्तः । उत्कर्षस्तु अभिव्यक्तिको भवति इदं पाणिं इदं चाप्य् इदं तेजसं इदं वायव्यं इदं आकाशीयमिति । Susruta, Sútras-thána Chap. 41)

The extant Charaka and Susruta—Succession of medical authorities :—

The extant Charaka and Susruta, the sources of our present information regarding the progress of scientific knowledge in the medical schools of Ancient India, are both redactions of original authorities. The extant Charaka is a redaction by Dridhabala of the genuine Charaka Samhitá which was itself a redaction by Charaka of the original work of Agnivesa, the disciple of A'treya Punarvasu as distinguished from Krishnátreya and Bhikshu A'treya, also well-known medical authorities. The extant Susruta is a redaction by Nágárjuna of an original work (Vriddha Susruta) by Susruta, the disciple of Dhanvantari. That Charaka preceded Susruta is almost certain. Nágárjuna was probably earlier than Dridhabala. At any rate, Dridhabala imported into Charaka much of the surgical knowledge which had till then been the traditional heritage of the Susruta school. And in the matter of the surgical treatment of certain diseases, the genuine Dridhabala is often as

advanced as Susruta's redactor himself. The latter was probably identical with the alchemist Nágárjuna (Siddha Nágárjuna), the metallurgist Nágárjuna (author of a treatise on metallurgy, Lohas'ástra), and the Buddhist Nágárjuna, author of the Mádhyamika-sútravritti. Charaka and Susruta continued to receive additions after Dridhabala and Nágárjuna, and even after Vágbhata, but the whole of the extant Charaka is probably much earlier than the commentator Chakrapáni, and the whole of the extant Susruta earlier than Dalvana, the commentator, and Mádhava, the author of Rugvinischaya. The extracts in Vágbhata make it certain that the passages I have quoted or shall quote from the Sústrasthána and Sárirasthána of Charaka and Susruta cannot be later than the sixth century of the Christian era.

Preparation of Chemical Compounds.—The knowledge of chemical compounds and of their preparation continued to make progress in the Charaka and Susruta Schools. The great metallurgist, Patañjali, in his treatise on Metallurgy (शिवाय) gave elaborate directions for many metallurgic and chemical processes specially the preparation of the metallic salts, alloys and amalgams, and the extraction, purification and assaying of metals. Probably it was Patañjali who discovered the use of the mixtures called *Vidas*.

which contained aqua regia or other mineral acids in potentia. Unfortunately Patañjali's *magnum opus* appears to have been lost, but extracts from it are frequently found in mediaeval works on Medicine and Rasáyana, which leave no doubt as to its remarkable scientific value. The metallurgist Nágárjuna advanced the knowledge of chemical compounds by his preparations of mercury. The Harshacharita, in the seventh century, relates a fable concerning this Nágárjuna, and speaks of him as a friend and contemporary of Sátaváhana. The relative priority of Patañjali and Nágárjuna is a vexed question in the history of metallurgy. That Nágárjuna's Lohasástra was earlier than the final redaction of Patañjali will appear from the following circumstances :—(1) Chakradatta in his summary of Nágárjuua mentions that the chemical process of testing pure iron must be repeated twice before it can be regarded as decisive, whereas S'ivadásá Sen's extract from Patañjali shows that the latter directed the process to be repeated seven times ; (2) Patañjali in the Abhraka-vidhi (mica operation) adds mercury, which in this particular operation is wanting in Nágárjuna's recipe (cf. Chakradatte, and Patañjali as reported in the Yogoratnákara-sa mūchchaya) ; and (3) Nágárjuna is quoted in the earlier compilations, Patañjali in the later.

Early in the sixth century, Varáhamihira in the

Vrihat Samhitá gives several preparations of cements or powders called Vajra-lepa "cements strong as the thunderbolt;" and there was ample use for these in the temple architecture of the Buddhist period, the remains of which bear testimony to the adamantine strength of these metal or rock cements. (पासादहर्षवलभीतिकृ-प्रतिमासु कुण्डकूपेषु सन्तसो दातव्यो वर्षतद्धसायुतस्थायो । Chapter 56, *Ibid.*). Varáhamihira also alludes to the experts in machinery (यन्त्रविदः, यन्त्रकाः) and the professional experts in the composition of dyes and cosmetics (रागगच्छयुक्तिविदः Ch. 16, also Ch. 15). I would also refer to the interesting Chapter on Perfumery (Ch. 76) where Varáhamihira gives various recipes for artificial imitations of natural flower scents as of the essence of Vakula, Utpala, Champaka, Atimuktaka &c., arranges compound scents in a sort of scale according to the proportions of certain ground essences used in their preparation, and determines by the mathematical calculus of combination (सोटकमस्तार) the number of variations of the different notes in this scale. To these classes of professional experts were due three of the great Indian discoveries in the chemical arts and manufactures which enabled India to command for more than a thousand years the markets of the East as well as the West and secured to her an easy and universally recognised pre-eminence among the nations of the world in

manufactures and exports :—(1) the preparation of fast dyes for textile fabrics by the treatment of natural dyes like Mañjishtá with alum (तुबरी मञ्जिष्ठा रागवन्धनी) and other chemical (e. g. sulphate of iron) also cow-dung (cf. the "cowdung substitute", Roscoe) ; (2) the extraction of the principle of indigotin from the indigo plant by a process which however crude is essentially an anticipation of modern chemical methods ; and (3) the tempering of steel in a manner worthy of advanced metallurgy, a process to which the mediæval world owed its Damascus swords. It was this applied chemistry much more than handicraft skill which gave India her premier position in the middle ages and earlier (indeed from Pliny to Tavernier) in exports and manufactures ; for in handicraft skill as in design and workmanship, great as were her merits, India came to be surpassed by her disciples China and Japan.

The Vásavadattá and the Dasakumára Charita in the sixth century allude to the preparation of a mass of fixed or coagulated mercury (पारद-पिण्ड इव कालधातुवादिनः—वासवदत्ता) ; a chemical powder, the inhalation of which would bring on deep sleep or stupor (योगचर्य—दशकुमारचरित) ; a chemically prepared stick or wick for producing light without fire (योगचर्त्तक—दशकुमारचरित) ; and a powder which like anæsthetic drugs or curare, paralyses

sensory and motor organs (सभन्तर्यनिव इन्द्रियाणाम्—वासवदत्ता—चीन्द्रियकर्त्त्वेन्द्रियाणामिति दर्थः). Vrinda (circa 950 A. D.) notices the preparation of sulphide of mercury (रसामृतचूर्चा) composed of one part of sulphur, and half its weight of mercury ; and also of cuprous sulphide (पर्फिटाम्). Chakrapáni (circa 1050 A. D.) mentions the preparation of the black sulphide of mercury, "by taking equal parts of mercury and sulphur".

The Rasárnava (circa 1200 A. D.) notices the colours of metallic flames, probably after Patañjali ; e. g. copper gives blue flame ; tin, pigeon-coloured ; lead, pale ; iron, tawny ; blue vitriol, red. It may be noted that the Rasárnava regards mercury as a penta-Bhautic substance.

The Rasaratna-samuchchaya divides the mineral kingdom (Earth-substances, simple and compound) into the following classes :— (1) The eight Rasas, mica, pyrites, bitumen, blue vitriol, calamine, etc. (2) The eight Uparasas (useful in operations of mercury), sulphur, red ochre, green vitriol, alum, orpiment, realgar, collyrium, and medicinal earth, to which may be added the eight Sádhárana Rasas, sal-ammoniac, cowrie, cinnabar, rock vermillion, etc. (3) The gems, diamond, emerald, sapphire, cat's eye, sun-stone, moon-stone, pearl, etc. (4) The metals,

gold, silver, iron, copper, lead, tin, and the alloys—brass and bell-metal. Other Earth-substances are six salts, three alkalis, mineral earths, and several poisons (cf. vol. I, pp. 32-98).

Chemical compositions and decompositions—metallurgic processes.—In these writings, we frequently come across instances of chemical composition and decomposition, by processes, more or less crude, of calcination, distillation, sublimation, steaming, fixation, etc. (भौकरण अधिपातन, ऊर्धपातन, खेदन, सत्त्वन etc.) e.g. the preparation of perchloride of mercury by taking common salt and mercury (रसकर्पूर—पारदस्य श्रेत-भौकरणे चन्द्रिकाकारः) ; of sulphide of mercury (हिष्पुल) by taking sulphur and mercury ; of Sindúra from lead (सिन्दूरं नागसम्बवम्—Amarakosha sixth century A. D.) ;—of the medicinal compounds, Svárna-sindúra and Rasasindúra, with mercury, sulphur and gold, where gold may have been fancied to influence the resulting compound in some mysterious way, either as a 'dynamic' or as a catalytic ;—also the extraction by chemical decomposition of mercury from sulphide of mercury (हिष्पुल,—vide रसरबसमुच्चय) ; of copper from sulphate of copper (तुल, सखक) by heating this substance with one-fourth of its weight of borax (Rasaratna-samuchchya,—cf. Bhávaprakásá, तुलं

तु ताक्षीपधातु किञ्चित् तामेण तद्यति) ; of zinc (वज्राम, जसद) from calamine (रसक—Rasarnava) ; of copper from pyrites (माल्चिक, विमल, etc.—Rasarnava, (though the golden pyrites were supposed to be a semi-metal of gold, containing some gold along with the essence of copper)—the purifications of mercury by repeated distillation from lead and tin with which it was wont to be adulterated in the market. The various metallurgic processes described are—extraction, purification, killing (formation of oxides, chlorides and oxy-chlorides for the most part), calcination, incineration, powdering, solution, distillation, precipitation, rinsing (or washing), drying, steaming, melting casting, filing, etc. to all which each of the known minerals was successfully subjected by the use of apparatus and reagents and the application of heat in different measures (खरपाक—मध्यमपाक—and महापाक),—methods which, if often crude, especially from the absence of independent and isolated mineral acids, were yet in several instances remarkably simple and effective, and which, after all by the use of various Vidas potentially containing mineral acids aqua regia, sulphuric acid, hydrochloric acid, etc.) virtually accomplished the practical ends kept in view. To these were added several special processes for mercury (e. g. fixation), bringing up the number of mercurial operations to nineteen.

It may be noted that the mixtures called *Vidas*, which potentially contained dilute mineral acids, were regularly employed not only in killing the metals (forming their oxides and chlorides), but—what is of fundamental importance—for purposes of chemical decomposition of metallic salts, etc. and the extraction and purification of metals.

Organic Compounds.—Organic Compounds are either vegetable or animal substances (खाद्य अज्ञन भूत). The molasses, the fermented liquors, the saps and juices of plants, fruit acids, vegetable ashes and alkalis together with the tissues of plants are vegetable compounds (जीवित खाद्य अज्ञन भूत). Honey milk, curd, butter, fat, bile, urine, and other excreta, together with the organs and tissues of animals, are animal substances. Charaka notices vegetable as well as animal oils. The viscous (oily) substances are classed under four heads—butters, oils, fats, and marrows (सर्पिलं वसा मज्जा बोहो हृदयमुर्विषः). Salt may be either mineral or vegetable salt.

Susruta divides poisons into two classes—Vegetable and animal, but several poisons expressly termed mineral poisons (चारुविष) are included in the first class.

All organic substances, whether animal or vegetable, are penta-Bhautic, being compounded

of greater or less proportions of the five Mahá-bhútas.

Taking the human body Charaka finds that the foetus is composed of sixteen organic substances, viz. four, composing the Sperm-cell which comes from the male; four composing the germ-cell which comes from the female; four added by the transformation of the nutritive material, and finally, four kinds of subtle matter, which together form the vehicle of the conscious principle. As to the four organic substances which compose the sperm-cell, or the other four which compose the germ-cell, it is not clear whether in Charaka's view they are also in their turn compounded of less complex organic substances, or whether their constituent elements are inorganic penta-Bhautic compounds.

The tissues that appear in the course of developments of the foetus are further transformations (higher compounds) of these foetal substances. All the component substances of the body are penta-Bhautic compounds, though sometimes they are assigned to the particular Bhútas which predominate in their composition, e.g. bile to Tejas, lymph, chyle, blood, fat, urine, sweat and other secretions to Ap, and skin, flesh, bones, nails, hair, etc. to Earth. (एको वायुप्रिभूत्वगुच्छपादवत् ।—गर्भस्त्र चत्वारि चतुर्विभानि भूताणि

मातापिण्डसभवानि चाहारज्ञानि चायम्भूतानि चेव et seq. Charaka, Sárirásthana, Chap. II. vide also Charaka, Sárirásthána, Chap. VII. cf. Gangádhara's Jálpakalpataru. पित्तं द्रवीयं भूतं श्रीरारथकतेजःप्रधानपच्चभूत-विकारात्मकं तेजःखद्वप्तमित्यन्तम् । कफश्चतुर्थं भूतमापः श्रीरारथकसीम-प्रधानपच्चभूतविकारविशेषः । श्रीरं तु पच्चमहःभूतविकारसमुदायात्मकम् । Cf. Charaka Sárirásthána, Chap. IV. मात्रादयोऽपि चक्रमहाभूतविकाराः ।)

Fœtal Development (after Susruta). The ovum fertilised by the sperm-cell and developing under the influence of animal heat forms successive layers and tissues even as layers of cells and fibres are formed in wood. First are formed seven layers epithelial and dermal (सप्तवचः), then follow the several tissues (कला:), the flesh, the vascular tissue, the fat and marrow, the lymphatic (and glandular) tissue, the intestinal tissues, the biliary and the seminal vessels,—tissues which are regarded by some as modifications of the original dermal layers of the ovum (cf. the layers of the blastoderm and their relation to the tissues in Embryology). The tissues are supposed to be developed successively, one out of another, by chemical action or metabolism (पाक), e. g. chyle is transformed into blood, blood into flesh, flesh into fat, fat into bone, bone into marrow, marrow into sperm-cell. The organs are next formed out of the tissues. The liver, gall-

bladder (लीम), spleen and lungs are referred to the blood ; the intestines to the blood, lymph and bile ; the kidneys to the blood and fat ; the testicles to the blood, lymph and fat ; the heart to the blood and lymph ; and the tongue to the lymph, blood and flesh. Váyu, with the accompaniment of animal heat, impels the 'currents' (जीवांसि) in the system ; Váyu acting on the flesh gives rise to the muscles, and it is Váyu again, which, with the essence of fat (or marrow), produces the nerves, arteries and tendons. (तत्त्व खलु यक्षोणितस्य अभिपच्चानन्दस्य वीरखेव सन्तानिकाः सप्तवचो भवन्ति ।—कलाः खल्पयि सप्त सञ्चवन्ति । वयाहि सारः काहेतु छियमानेतु हृशते । तासा प्रथमा मांसधरा । द्वितीया रक्तधरा । दृतीया मेदीधरा । चतुर्थी श्वेषधरा । पञ्चमी पुरोषधरा । षष्ठी पित्तधरा । सप्तमी यक्षधरा ।—गर्भस्य यज्ञत्रौहानो शोणितजी ।—et seq Susruta, Sárirasthána, Chap. IV.—रसाद्रक्तं ततो मांसं मांसान्वेदः प्रजायते । मेदसी॒श्च तती मन्त्रा मन्त्रः यक्षस्य सञ्चवः । Sútrasthána, Chap. XIV.)

The following parts (tissues and organs) in the fœtus are in a special sense modifications of the four organic substances contributed by the sperm-cell of the male parent ; hair, nails, teeth, bones, nerves, veins and arteries, tendons and ligaments, and the sperm-cell ; the following, of the substances derived from the mother,—skin, blood

flesh, fat, the heart, liver and spleen, kidneys, stomach, intestines, etc. (Charaka, Sáriasthána, Chapter III. यानि खल्स्य गर्भस्य पिण्डानि पिण्डतः सच्चवतः सच्चवति, तदयथा केश-उमसु-गृह्ण-खोम-दक्षालिंगिरा-खायु-धमन्वः युक्तमिति पिण्डानि । यानि खल्स्य गर्भस्य माद्रानि यानि च अस्य माद्रतः सच्चवतः सच्चवति—तदयथा त्वक् च खोडितव्य मासस्य मेहस्य हृदयं च यजूत् च प्रीहा च हङ्कौ च पुरीषाधानं च आमाशयस्य इति माद्रानि ।)

Chemistry of Digestion—The food we eat contains five classes of penta-Bhautic organic compounds. From their radicles or predominant elements, the substances are named Earth-compounds, Ap-compounds, Tejas-compounds, Váyu-compounds and A'kása-compounds. The Earth-compounds supply the hard formed matter of the body, the Tejas-compounds give the animal heat (or the metabolic heat), the Váyu-compounds are the sources of the motor force in the organism, the Ap-compounds furnish the watery parts of the organic fluids, and the A'kása-compounds contribute to the finer etheric essence which is the vehicle of the conscious life. Roughly speaking, the Earth-compounds answer to the nitrogen compounds in the food, the Tejas-compounds to the hydro-carbons (heat-producing) and the Váyu-compounds to the carbo-hydrates (dynamic). The Ap-compounds are the watery parts of food

and drink. The flesh, for example, is a tissue composed principally of the Earth-compounds, the fat of the Earth and Ap compounds, the bones of Earth Váyu and Tejas compounds. The Tejas compounds predominate in the composition of the blood. For purposes of digestion it is stated that different operations of the metabolic heat (perhaps different digestive fluids are also meant) are required to digest the different substances in the food.

The course of metabolism is described as follows :—The entire alimentary canal is called Mahásrotas (the great channel).

The food goes down the gullet by the action of the biomotor force, the Prána-Váyu.

In the stomach (आमाशय) the food becomes mixed up first with a gelatinous mucus (फेणीभूतं कफं) which has a saccharine taste, and then gets acidulated by the further chemical action of a digestive juice (षिदाहादक्ता गतः)—evidently the | gastric juice is meant. Then the biomotor force, the Samána Váyu, begins to act and drives down the chyle by means of the Grahaní Nádī to the Pittásaya (duodenum), into which bile comes down from the liver, and thence to the small intestines (the आमपक्षाशय). In these, the bile (or rather the digestive substance in the bile as opposed to the colouring element) acts on the chyme, and converts the latter into chyle (रस), which has at first

a Katu taste (pungency). This chyle contains in a decomposed and metamorphosed condition all the penta-Bhautic organic compounds, viz. tissue-producing Earth-compounds, water parts or Ap-compounds, heat-producing Tejas-compounds, force-producing Váyu compounds, and lastly, finer etheric constituents which serve as the vehicle of consciousness. The essence of chyle (श्वसमाग) from the small intestines is driven by the biomotor force, the Prána Váyu, along a Dhámaní trunk (cf. the thoracic duct) first to the heart (which is a great receptacle of chyle), and thence to the liver (and the spleen), and in the liver, the colouring substance in the bile acts on the essence of chyle, especially on the Tejas substance therein, and imparts to it a red pigment, transforming it into blood. But the grosser part of chyle (श्वसमाग) proceeds along the Dhámanís, being driven by the biomotor force, the Vyána Váyu, all over the body.

When the blood has been formed, the essence of chyle in the blood, acted on by Váyu (biomotor force) and Mámságñi (the flesh-forming metabolic heat), forms the flesh tissue, the Earth-compound of the food substance especially contributing to this tissue. Of the flesh tissue thus formed, the grosser part goes to feed or replenish the flesh tissue all over the body. The finer essence of flesh in the

blood in the chyle, acted on again by Váyu (biomotor current) and the fat-forming metabolic heat (मेदोऽपि) in the menstruum of lymph (कफ समाधित), receives viscosity and whiteness, and produces the fatty tissue, the Earth-compounds and Ap-compounds of the food especially contributing to the product. This fat in the chyle (or blood), or rather the grosser part of it replenishes the fatty tissue of the body, but the finer essence of fat in the flesh in the blood in the chyle, acted on by Váyu (biomotor current) and the marrow-forming metabolic heat, in the menstruum of lymph (श्वेभूषःहत), becomes hard (or crystalline), and forms bone, the Earth, Váyu and Tejas compounds contributing principally to the product. The essence of the fat fills the hollow channels of the bones, and acted on again by biomotor Váyu and metabolic heat, becomes transformed into the marrow. The marrow is transformed into the semen, which is conveyed down by means of a pair of Dhamanis (ducts) (द्वे शक्तव्य), lodged in its receptacles (यन्त्रपरा—ठबणी) and discharged by means of another pair of ducts (द्वे विचुर्गाय). The semen, or rather all the elements in their finer essence, give off Ojas, which returns to the heart, the receptacle of chyle and blood, and again floods the body, and sustains the tissues, thus completing the wheel (or self-return-

ing circle) of metabolism (पारदर्शिता चक्रवत्. Cf. Charaka and Vāgbhata).

It is to be noted that, throughout, the fluid in the chyle (or blood) acts as the menstruum, though occasionally the lymph, which is itself a derivative from the chyle is added as in the case of the fatty tissue and the marrow ; and that each preceding element or constituent of the body (खाति—अरीरारथकधातु) takes up the proper organic compounds from the food-chyle to form the next element or tissue. Throughout also, the chemical changes are due to the metabolic heat which breaks up the compounds and recombines, but the operations and even the vehicles perhaps of this heat are different. For example, these heat-corpuscles in the biliary ducts produce the bile, but the bile secretion is supposed to contain two distinct substances, (1) a digestive fluid in the duodenum (विचाय) which acts on the chyme to produce the chyle, (अप्रस यजूपाचकास्ति पित्त) ; and (2) a colouring bile substance in the liver which adds a red pigment to the chyle and transforms it into blood (रक्ताद्वयं पित्तम्). Besides, there are three other biles, of which the aqueous humour in the eye is supposed to be one (आळोचकपित्तम्) helping in the formation of visual images (रूपदात्वकम्). This is the view of Dhanvantari and his school, but Atreya holds there is no

evidence that the bile really performs the first (digestive) function, for this can be accounted for by the animal heat arising from the working of the whole bodily machine. There are three different hypotheses regarding the course of metabolism and the successive transformations of the chyle (चोरदधिन्याय-कीदारोकुल्यान्वाय खलेकरीतन्यादेति विषा धातुपीषण-क्रमः—Chakrapáni, Bhánumatí, Sústrasthána, Chap. 14, S'loka 10 ; also his commentary on Charaka, Sústrasthána, Chap. 28), but my account is based upon the second hypothesis which has the preference of Ckakrapáni (स्वरसः). It may be added as a curiosity that each element of the body (धातु) under the metabolic heat is supposed to give off a finer essence (पूज्ञमाण) which serves as the material of the next succeeding element, and a dross (मृद), which forms some of the excreta in the body (including the nails, the hair, etc.), besides retaining its own substance (the gross or main part) .which is driven along by the Váyus (biomotor or vital currents) or by the Srotas to its destination in the body. Some idea of circulation appears to have been entertained, for the heart which receives and then sends down the chyle through the Dhámanás gets it back transformed into blood, and the Ojas also proceeds from the heart and returnes to it along with the chyle and blood. (Cf. Vágbhata—ताः इत्यसाः विराः रक्ताभ्यं चीजः

अभिवहन्तः)। पच्चभूतात्मके देहे आहारः पाच्चमौतिकः। विषः
पच्चधा सत्यग्रुणान् स्वागभिवर्दयेत्। Susruta, Sústrasthána,
Chap. 46. Cf. also विषत्पवनजातात्मां डिहिमाप्नोति जातः।
आदीयमेव बहुद्रव्यं तेज पित्तमुदीर्घते। Ibid., Chap. 41.
मौमाप्ताप्येवायत्त्वाः पच्चीमाणः सनाभसाः। पैचाहारग्रुणान् स्वान्
स्वान् पार्धिवादीन् पच्चत्यनु। यथास्वं ते च पुच्छन्ति पक्षा भूत-
ग्रुणान् पृथक्। पार्धिवाः पार्धिवानेव शेषाः शेषाः देहगान्।
अतिरिक्ता गुणा रत्ने वज्रेमांसि तु पार्धिवाः। मेदस्पां सुवशास्ति
पृथिव्यनिखत्तेऽसाम्। Charaka, quoted by Dalvana. आदी
षड्रसमप्यन्नं भृत्रीभूतमौरयेत्, केषीभूतं कफं याते विदाहादन्तां
ततः। बायुना समानात्मेन यहस्तीमभिनौयते। षष्ठो पित्तधरा जाम-
वा कला परिकौर्तिता। आमपकाश्यान्तःस्था यहस्ती साइमिकीयते।
अन्वचित्तानमद्रस्य यहस्ताद्यहस्ती मता। सुक्रमामाशये रक्ता सा
विपाच्य नयत्वः। वस्त्रदत्यवसा लक्ष्मानमेव विमुचति।...चप्तस
पक्षु पित्तनु पाचकात्मां पुरेपिदम्। दोषधातु-क्लादीनामुद्भेद्या-
वेयशासनम्।...तीव्रोरसानां सर्वेषामम्बुजानां यदुच्यते। पित्तोरसा
सरानेत्र रसो रक्तलक्ष्मृति। वायुप्रितेजसा युक्तं रक्तं मास-
त्वमृक्षति। शेषमात्मं च समाशिव्य मांसं वायुप्रिरंयुतम्, ल्लिंगता
प्राप्य शौक्लं च मेदो देहेभिन्नायते। पृथिव्यनिखत्तादीनां सज्जातः
श्रीप्रसादतः। खरस्वं प्रकरोत्स्वं जायतेऽस्य तती शृणाम्। करोति
तद शौचित्यमस्युः सध्ये समीरेः। मेदसा तानि पूर्णं ते खेडो
नस्ता ततः चृतः। तदानन्तरं यः लेहः शङ्कं संजायते ततः।

Charaka—Dridhabala Samhitá, quoted by Aruna in his commentary ou Vágbhata. यथा केदारनिषत्तं कुरुत्याजलं प्रव्याप्त्वा केदारीमाप्नावयति, तथा रस एव प्रथमं रक्तं प्रावयति। तच रक्तस्थान-सम्बन्धात् रक्तसाहस्रं रक्तव्यपट्टेण च अनुभवति। रक्तं च रक्तसमानेन सौकिनाशेन अस्ति पोषयति। तसो रक्तमाप्नाव्य मांसमाप्नावयति, एवमुत्तरोत्तरधातृन् रस एव प्रावयति। (Chakradatta, Bhánumatí). This passage shows that the ‘venous blood’ was conceived to be chyle-essence mixed with blood, and that the circulation of the chyle so far as it was held to contribute its quota to the constituent elements and tissues of the body was really supposed to be identical with the circulation of the blood (ततो रक्तमाप्नाव्य मांसमाप्नावयति). This will be abundantly clear from the following account of the course of the chyle and the blood :—

तदः सारभूतस्याहाररसस्य हो भागी भवतः। स्थूलः सूक्ष्म...
 ततः सूक्ष्मो भागः प्राणवायुना प्रेरितो धमनीमार्गेण शरीरारभक्षय रक्तस्थ स्थानं यक्तत् प्रोहक्षयं गत्वा तेन सह मिलितो भवति।
 ततः प्राक्तन-रक्तधातृ एव तिष्ठति।.....ततः सारभूतस्य आहार-रसस्य हो भागो भवतः। स्थूलः सूक्ष्म। सूक्ष्मो भागी रंजकास्थेन पित्तेन रक्तोक्ततः शरीरारभक्षय रक्तं पोषयन् व्यान-वायुना प्रेरितो धमनीभिः संचरन् सकलशरीरगतानि रक्षित्यि पुण्याति।
 ततः सूक्ष्मो भागः व्यानवायुना प्रेरितो धमनीभिः शिराभिः शरीरारभक्षय मांसानि याति। et seq.

This finer essence of chyle which nourishes the flesh must also be carried in the blood, on the 'irrigation channel' hypothesis (किदारोकुञ्चान्वाय). (For diagrams of the central circulation and the sympathetico-spinal nervous system, *vide* my Paper on Hindu Anatomy and Physiology. The mechanism of life and the inheritance of specific and other congenital characters are also dealt with in the same paper).

Formation of molecular qualities in chemical compounds :—The Charaka school, which, we have seen, was an offshoot of the Sánkhyā (cf. Charaka, Vimánasthána, Chap. 8, यथा बादित्यः प्रकाशकः तथा संस्कृतवृत्तं प्रकाशकमिति) supplemented the above account of inorganic and organic compounds with a characteristically Sánkhyā explanation of the formation of molecular qualities by chemical combination. In Charaka's view, the colours, tastes, etc. of the molecules of chemical compounds result from the collocation in unequal proportion and unstable equilibrium of the different forces latent in the atoms (Paramánuṣ) themselves. (एवमेतेषां रसाणां चट्टलमुपपत्रं गृह्णातिरिक्त-चित्रिषात् महामूर्ताणां। भूताणामिव खावरजडमाणां नानावर्णाङ्गति-विज्ञेषाः। Charaka.)

Chemistry of colours.—As an interesting example of the way in which a follower of Charaka would account for the colours of chemical compounds, I may note the explanation given by the late Gaṅgādhara Kavirāja Kaviratna in the *Jalpakalpataru*, a commentary on the *Charaka-Samhitā*, published at Calcutta in 1869, premising that the Kaviraja's view is pure and genuine Charaka doctrine. Gaṅgādhara begins with a simple statement. The qualities of the atom, he writes, tend to produce similar qualities in the molecule. A molecular quality is therefore the result of the conjunction or opposition, as the case may be, of the atomic tendencies. When, for example, the five Bhūtas combine to produce an organic compound (the human body), Tejas, Ap and Earth tend to produce red, white and black respectively, but in the body (compound substance) the yellow colour may happen to be produced as the result of these tendencies in that particular proportion and collocation. The point to note here is that the molecule forms a fresh collocation, *redistributes the Mass and Energy*, and sets up new forces in the system which coming into play modify the potencies (or tendencies) in the component atoms and thus determine the resultant. This is elaborated into a curious but complete theory of the colours of chemical compounds.

The colours (and other qualities) of a simple substance (an isomeric mode of any Bhúta) are the result of the potencies lodged in that particular collocation of Mass, Energy and Essence. Now when two such substances unite, their colours etc. tend to be produced, but the combination brings on a fresh distribution of Energy, Mass and Essence, and the forces thus set free may powerfully modify or even extinguish the separate tendencies or potencies of the component simple substances. For example, when we prepare a collyrium by mixing equal parts of sulphur and mercury (the black sulphide of mercury), we find the resulting compound black. To explain this, it has to be remembered that each of the substances (sulphur and mercury), contains Sattva (Essence), Rajas (Energy) and Tamas (Mass) in different proportions, and that predominant Tamas (Inertia, Mass) always produces black, predominant Sattva (Essence) white and predominant Rajas (Energy) red. Now in the black sulphide of mercury, the white of the mercury tends to produce white and the yellow of the sulphur yellow ; and if these tendencies were not obstructed, the result would be a mixed colour. But, in the particular collocation in question, the Tamas of the mercury becomes intensive (तीव्र), and the black of the now intensive Tamas

extinguishes the white in the uncompounded mercury, which was due to prevailing Sattva, as well as the yellow of the uncompounded sulphur, which was due to the combined operation of white-producing Sattva and red-producing Rajas. Again, when, with proper apparatus and by the application of heat, we combine mercury and sulphur to produce the red sulphide of mercury, the resulting colour is explained by the fact that in this new collocation the Rajas (Energy)—probably of the mercury, though Gaṅgādhara does not specify—becomes intensive (तीव्र), and extinguishing both the white-producing Sattva of the mercury and the yellow-producing Sattva-Rajas of the sulphur, imparts a red colour to the compound. In these cases, as also in the formation of red by mixing powdered turmeric with lime, i.e., whenever a new colour is produced in the compound it is to be explained by the dominance of Tamas, Rajas or Sattva, or their combinations, and the extinction of the uncompounded tendencies (or potencies) by the forces set free in the new collocation. But there are other cases where the colour of the compound is a mixed colour resulting from the colours of the combining substances, e.g., when sulphide of mercury and calcined tin are mixed, the resulting colour is evidently a mixed one (Pātala, pink), which is

easily explained by the colours of the component elements (the red of the sulphide of mercury and the white of the calcined tin). In the same way, in a mechanical aggregate, as in a piece of cloth, the colour is white, where the threads are white.

(तत्कार्यारम्भे पृथिव्यादिद्रव्यावस्थागुणा गन्धादयः खलु स्त्रं
आतौयं गन्धविशेषादिकं आरभमाणाः यदारभमाणं स्त्रस्विजातौयं
कार्यं स्वारभकं कारणश्च अहमारादिस्तं गुरुंश्च उभयान्
कुञ्चित् हत्वा कुञ्चित् न हत्वा स्त्रातौयं गुरुविशेषं आरभन्ते ।
यथा पारदगन्धकयोः संयोगे कञ्जलीमूत्रद्रव्ये पारदस्तः शुक्रः शुक्र-
विशेषं आरभमाणः गन्धकस्थपीतः पौत्रमारभमाणः पारदस्तोत्तमोन्
तैष्यमारभमाणेन विरोधिना वर्धते । सर्ववैव शौक्रां सत्त्वगुणयोनिकं
तमोगुणयोनिकेन तैष्येन विरोधिना वर्धते । गन्धकस्थपीतस्यौ च
खोहितशक्तौ रजःसत्त्वयोनिकौ वर्धते । तदेऽ शुक्रांहितवचे तैष्यस्त-
समानयोनिः छाणः अभिव्यक्तते । इति पारदगन्धकोभयाके कार्ये
श्रेतपीतमेलनेन समाप्तं कार्यं यदृश्ये तत् तोच्चागुणेन वर्धते,
तत्कारणं शुक्रांहितं हत्वा । एवं हितुसे पारदगन्धकाभ्यामारभमाणे
यज्ञविशेषे वाङ्गमि पञ्चमाणे रजोबहुलयोनिकेन तौरुणेन समाप्तं
योनिकौ शुक्रशक्तौ वर्धते । पारदस्तशुक्रगन्धकस्थपीतमेलनेन समाप्तं
कार्यं वर्णे च वर्धते । रजोयोनिक्षोहितं च अभिव्यक्तते इति ।
एवं हरिद्राचूर्णसंयोगेऽपि खोहितं अभिव्यक्तते चूर्णस्तैष्येन हरिद्रास्य
शुक्रशक्तवचे । अथ अवस्थे यथा—हितुसत्त्वमूलसंयोगे श्रेतकोहित-
वर्षमेव उभयाकरं भवति पाट्टवर्णं, न च तत्र हितुसत्त्व-

खोडित्यं वज्रभक्षसं शीक्षा च केनापि वर्णते। एवं युक्तसूच-
निर्वितपटस्य शीक्षामेव।) (Jalpakalpataru, Sústrasthána-
of Charaka, pp. 198-200; edition published
by Bhubanachandra Basík, Calcutta, Samváda-
ratnákara Press, Samvat 1925.) This is quite
in a line with Charaka's explanation of the tastes
of chemical compounds which has been already
noticed.

Parináma-váda versus Árambha-váda : Charaka's view of the formation of a new quality or a new substance is based on the Sáñkhya teaching as to the conservation and transformation of Energy, and brings chemical synthesis in a line with evolutionary change (परिणाम). On this view, a new substance may arise by spontaneous or isometric change, i.e., by the inter-play of Energies within the system of any given substance, in the absence of any action from without. New qualities like new substances are only readjustments of the old, and continual changes are going on by spontaneous disintegration and recombination. Opposed to this evolutional view of chemical synthesis is the Nyáya-Vaisesika doctrine of Árambha-váda, according to which no change of substance or quality, no effect, in short, can take

place except by the action of one component element (substance or quality) on another. A binary molecule, for example, cannot possess any 'specific quality' (स्पेशियल) of a kind not represented in each of the two component atoms. In the cosmic process, no atom can exist free and uncombined with another atom, and every 'specific quality' in a substance can be ultimately analysed into the union of two 'specific qualities' *of the same class* in two ultimate particles which cannot be further divided. A single colour, smell or taste in a single particle, until it can link itself on to another specific quality *of its own class* in a second particle, cannot characterise any substance formed by the union of these particles as material causes. Hence an Earth-atom cannot unite with an Ap-atom, to form a new substance of which both the particles must be equally regarded as material causes. At any rate, such a compound, if effected, would be smell-less, as of the two constituent atoms, only one, viz. the Earth-atom, possesses smell. A compound of Earth and Váyu would be smell-less, colourless and tasteless, and so on. The Nyáya-Vaisesika does not deny that there may be compounds of different Bhútas, nor does it deny the causal operation of specific qualities as efficient or energising (dynamic) causes (उपदध्यक, निमित्तकारक) but it refuses to place

these compounds on the same footing as compounds of isomeric modes of the same Bhúta ; and it accepts the 'material' causality, in such cases of only one of the Bhútas, regarding the others as 'co-efficients' (लिमितकारण).

The earlier Sánkhyas including the medical schools of ancient India brushed all this aside as a distinction without a difference. The Vedantists, as we shall presently see, flouted this doctrine of A'rambha-váda. The Jainas, in opposing this Vaisesika view of atomic combination, hit upon a solution of the problem of chemical affinity. Others again, found out a *via media*. They held, as we learn from the reports of Udyotakara in the Nyáya-vártika, and of Váchaspati Misra in the Tátparyyatíká, that a molecule of the structure EA (one atom of Earth and one of Ap) would exhibit some variety of colour and taste resulting from the joint action of the atoms and of their several colours and tastes. But as in the combination EA only the Earth-atom possesses smell, and the Ap-atom is smell-less, and as moreover no quality in a compound substance can result except from the joint action of the similar (potential) qualities of at least two component elements, it follows that a molecule of the structure EA would not manifest the energy of smell potentially contained in the Earth-atom.

Hence, admitting the combination EA for a smell-less compound, the upholders of this view would suppose a molecule of the type E, A (i. e. two atoms of Earth and one of Ap) to explain any bi-Bhautic compound of Earth and Ap (like the plant saps and fruit juices) which exhibits smell in addition to the peculiarities of colour and taste. (Cf. Váchaspati's comment on Udyotykara's refutation of this view :—

अथमधिसन्धिः । पृथिव्याप्यपरमाणुं तावत्रेकं द्रशुकमारब्धभु-
महंतः तदोः क्षपरसस्यर्थवलेन तदारभसम्भवे अपि गम्बवस्त्वा-
भावप्रसङ्गात् । एवं पार्थिवाणु समवेतस्य गम्बस्य एकत्रेण अनारभ-
कत्वात् नापि पार्थिवपरमाणुहयं एकय पार्थिवपरमाणुः इति
अणुनामारभकत्वे गम्बवस्त्वोपपत्तिः इति साम्यतः । परमाणुनां बहुनां
अनारभकत्वात् । तथाहि वयः परमाणुवः न कार्यमारभते ।)

Measures of Time and Space. Size of atoms.

The Siddhánta-Siromani gives the following measures of Time :—

30 Kshanas = 1 day, 2 Ghatikás = 1 Kshana,
 30 Kalás = 1 Ghaṭika, 30 Káshthás = 1 Kalá,
 18 Nimeshas = 1 Káshthá, 30 Tatparas =
 1 Nimesha, and 100 Trutis = 1 Tatpara.

This makes a Truti of time equal to $\frac{1}{33\frac{1}{3}}$ of a second, which is nearly the measure of

the Paramánu of time; as given in the Vishnupurána (vide Bháskara's Siddhánta-Síromani—कालमानाध्यायः) !

The above measures were in use among the astronomers, but the physicists computed according to the following table given both in Udyana's Kiranávali and S'rí Bhara's Nyáyakandali :— 30 Muhúrtas = 1 day (24 hours), 30 Kalás = 1 Mu-húrta, 30 Káshthás = 1 Kalá, 18 Nimeshas = 1 Káshthá, 2 Lavas = 1 Nimesha, 2 Kshanás = 1 Lava.

क्षणहयं लवः प्रीतो निमेषस्तु लवहयम् ।

अट्टादश्चन्मेषास्तु काष्ठा विश्वनु ताः कला ।

द्विश्वनुकला तुहर्त्ता स्यात् द्विश्वद्राच्यहर्षी च ते ।

(Udayana, Kiranávali).

This makes 1 Kshana of the Nyaya-Vaisesika equal to $\frac{2}{3}$ of a second. The Nyáya assumes that the unit of physical change (or the time occupied by any single antecedent step in a causal series before the succeeding step is ushered in) is equal to a Kshana (or $\frac{2}{3}$ of a second). The astronomers were familiar with far smaller measures of time. The astronomical Truti of time measures about the thirty-four-thousahdth part of a second. This is of special value in determining the exact character of Bháskara's claim to be regarded as the precursor of Newton in the discovery of the principle of the Differential Cal-

culus, as well as in its application to astronomical problems and computations. This claim, as I proceed to show, is absolutely established ; it is indeed far stronger than Archimedes's to the conception of a rudimentary process of Integration. Bhāskara in computing the "instantaneous motion" (तात्कालिकी गति) of a planet compares its successive positions, and regards its motion as constant during the interval (which of course cannot be greater than a Truti of time, though it may be indefinitely less). This tatkālīka motion is no other than the differentia of the planet's longitude, and Bápudeva Sástrí claims that both the conception of the instantaneous motion and the method of determining it plainly show that Bhāskara was acquainted with the principle of the Differential Calculus. On the data before him, Mr. Spottiswoode remarks that Bápudeva Sástrí "overstates the case." Bhāskara "makes no allusion to one of the most essential features of the Differential Calculus, viz., the infinitesimal magnitude of the intervals of time and space therein employed. Nor indeed is anything specifically said about the fact that the method is an approximate one." "With all these reservations" Mr. Spottiswood continues, "it must be admitted that the formula he establishes and the method of establishing it

bear a strong analogy to the corresponding process in modern mathematical astronomy" (*viz.*, the determination of the differential of the planet's longitude,—by no means the first step in transcendental analysis or in its application to astronomy). And Mr. Spottiswoode concludes by stating that mathematicians in Europe will be surprised to learn of the existence of such a process in the age of Bhāskara (*circa* 1150 A. D.—born 1114 A. D.). Mr. Spottiswoode's second objection that Bhāskara does not specifically state that the method of the Calculus is only approximative cannot be taken seriously. The conception of limit and the computation of errors came late in the history of the Calculuses of Fluxions and Infinitesimals. For the rest, Bhāskara introduces his computation expressly as a "correction" of Brahmagupta's rough simplification. The first objection (*viz.*, that Bhāskara makes no allusion to the infinitesimal magnitude of the intervals of space and time employed) would be more to the point, if it were well founded. But it is not, and Mr. Spottiswoode's error was due to the insufficiency of the data supplied to him. As a matter of fact, even Bhāskara's unit, the Truti of time (or Paramānu), is exceedingly small as the very name implies, being about one thirty-four-thousandth of a second of time. And in the passage in which Bhāskara describes the process, he distinguishes

between: Sthúla-gati and Súkshma-gati (velocity roughly measured, and measured accurately i.e., by reference to indefinitely small quantities, for Súkshma, as we have seen, has always a reference to the Anu, the indefinitely small). Indeed he expressly mentions that the Sthúla-gati takes only Sthúla-kála (finite time) into consideration, and that the determination of the Tátkálikí Gati (Súkshma-gati) must have reference to the moment (प्रतिक्षणम्), which is an indefinitely small quantity of time being of course smaller than his unit, the Truti. (Cf. इयं किञ्च स्थूला गतिः अथ सूक्ष्मा तात्कालिकीं कथ्यते.....यदा आसन्नक्षिप्ततासदा तात्कालिकशा गत्वा तिथिसाधनं कर्तुं युज्यते । तथा सभीपचाखनश्च । यदा तु दूरतरक्षिप्तम् द्वाराज्ञानं वा अन्दस्य तदा आद्यया स्थूलया कर्तुं युज्यते: स्थूलकालाभावात् । यदाहमेवदगदिः । महत्त्वात् प्रतिक्षणं समा न भवति अतकादर्थे अयं विशेषीभिर्भितः ;—nothing can be clearer than this conception of ‘momentary’ motion.—Bháskara, Siddhánta-Síromani, Ganitádhya, Gatisphutíprakarana : cf. also प्रतिक्षणं सा न समा महत्त्वतः; ibid., cf. also Goladhyáya, Tátkálikí-karana-vásaná-prakarana, where Bháskara points out that the mode of computing adopted by the Áchárya (Brahmagupta) is a rough simplification. The computation of relative motion and the idea of resolved component motion were of course familiar to

the astronomers.—(Cf. एवं सत्याचार्येष्व लाघवादें इष्टस्तो-
सम्भिकी गतिकरा अकेमिसाः । *ibid.*) I may add *en passant* that Bhāskara's formula for the computation of a table of Sines also implies his use of the principle of the Differential Calculus.

Measures of weight and capacity. The Amarakosha mentions measures of three kinds—weight, length and capacity (मानं तुलाऽङ्गुष्ठिमस्यः).

The Krishnala (Guñjá, Raktiká, the black and red berry of the Shrub Abrus Precatorius) was employed as a natural measure of weight. 80 Krishnala berries on the average weigh 105 grains Troy, and this must be taken as the basis of our computation, though in current practice 80 Krishnalas are taken to be equivalent to 210 grains. One Krishnala was supposed to weigh as much as 3 medium-sized barley seeds (मध्यधन), one of the latter as much as 6 white mustard seeds (गौरसंबंध), one white mustard as much as 3 Ráji mustard seeds (राजिसंबंध), one of these seeds as much as 3 Likshas, and one Liksha as much as 8 Rajas or Trasarenus.

We now come to conventional measures. One gold Máshá was the weight of 5 Krishnalas of gold, 1 Suvarna or Tolá weighed as much as 16 Máshás, and one Pala as much as 4 Suvarnas or Tolás. A Pala of gold therefore weighs 320 Krishnalas (Mann, Chap. VIII, Vishnu, Chap. IV, and Vájrasalkya, Chap. 1).

A Máshá of gold therefore would weigh $\frac{6}{7}$ grains ; a Tolá, 105 grains (in current practice it weighs nearly double as I have stated) ; and a Pala, 420 grains Troy.

The measures for silver were the following :—
 1 Silver Máshá = 2 Krishnala, 1 Dharana = 16 Silver Máshás and 1 Pala = 10 Dharanas. A Pala of silver would therefore weigh 320 Krishnala. In other words, the Pala was a fixed measure of weight, and was equal to about 420 grains Troy, or double this, if we take the Krishnala of current practice.

A Pala, which equals 320 Krishnala, was subdivided by 4, 16 and 5 successively for gold, and by 10, 16 and 2 successively for silver. A Suvarna (or Tolá) of gold corresponds roughly to a Dharana of silver, and a gold Máshá to a silver Máshá, but the sizes (or volumes) are not the same, and we must not therefore conclude that gold was supposed to be heavier than silver in the proportion of 5 to 2.

We find that 1296 Trasarenus equal 1 Krishnala. A Trasarenu, as a measure of weight, therefore, is the equivalent of $\frac{7}{8712}$ of a grain Troy or double this according to current measures.

But the Trasarenu of physics is a different conception. It stands for the *minimum visible*, i.e., as the physicists define it, that which is *just discernible* as a glancing particle in the slan-

ting beams of the morning (or afternoon) sun, coming into dark room through a chink or orifice of a window. This is a measure of size (or rather stimulus limen).

Measures of Capacity. Here the standard was furnished by the Kudava (कुदाव), a vessel described as 3 Āngulis long, 3 Āngulis broad, and 1½ Ānguli deep,—with a cubical capacity of 13½ cubical Āngulis. 4 Kudavas=1 Prastha, 4 Prasthas=1 A'dhaka, 4 A'dhakas=1 Drona, and 4 dronas=1 Khári or Bhára.

24 Āngulis make 1 Hasta, cubit, which may be taken to be 18 or 19 inches. A Kudava was divided into 4 Palas, and there can be no doubt that originally water of the weight of 4 Palas was found to be actually contained in a vessel of the cubical capacity of a Kudava. If we take the ancient cubit to have been 19 inches, the Kudava would contain nearly 4 Palas of distilled water at 30 Centigrade. On a cubit of 18 inches, the Kudava would contain about 3 $\frac{3}{7}$ Palas.

The Kudava in current medical practice is supposed to represent a cubical vessel, each side being 4 Āngulis. This would give a capacity of 27 cubic inches, if we take the modern cubit of 18 inches. The Kavirájas take a Kudava to contain 8 Palas of water, and as 1 Pala=320 Krishnalas, and 80 Krishnalas are now taken to be equal to 210 grains Troy, a vessel of a capacity

of 27 cubic inches is accordingly supposed to contain about 6720 grains Troy,—which is not very wide of the mark, being about 1·3 per cent short for distilled water at 86° Fahrenheit or 30° centigrade.

Size of the *minimum visible*; size of an atom.

The supposed thickness of the just discernible mote in the sunbeam called a Paramánu in Technology, S'ilpa-sástra, (and a Trasarenu in Natural Philosophy, follows directly from Varáhamihira's table :—8 Paramánus make 1 Rajas (or Ratharenu,—cp. the Mánasára), 8 Rajas make 1 Bálágra (filament of hair), 8 Bálágras make 1 Likshá, 8 Likshás make 1 Yúká, 8 Yúkás make 1 Yava, 8 Yavas (the Mánasára has 4) make 1 Anguli (superior), 24 Angulis make 1 Hasta (cubit, lesser cubit, 18 inches). The thickness of the *minimum visible* (the finest perceptible mote in the slanting sunbeam) is therefore taken to be 3.2^{-20} or $\frac{1}{3145723}$ of an inch. The volume of a spherical Trasarenu (or Paramánu of the S'ilpa sastra) would therefore be $\frac{4}{3} \pi 3^{-20} \cdot 2^{-63}$ of a cubic inch. It may be here noted that such a Trasarenu is supposed in the medical schools to contain 30 chemical atoms (Paramanus of Natural Philosophy) according to one estimate, or 60 according to another. The size of an atom must then have been conceived to be less than $\pi 3.5^{-1} \cdot 2^{-62}$ of a cubic inch.

परमाणुरजीवात्मायस्तिष्ठुकं यतोऽनुलं चेति च दग्धानि यथोत्तरम् च इ

मेकं भवति संस्कार—Varáhamihira, Vrihatsamhitá, chap. 57. S'loka 2—जात्यान्तरगते भानी यदृष्टतरं दर्शनं रक्षो वाति विद्यात् परमाणुं प्रथमं तद्वा प्रमाणानाम् । *ibid.*, S'loka I,—Cf. Utpala, तत्परमाणुं नाम प्रमाणं जानीयात् । प्रमाणानां सर्वेषां तत् प्रथममाणं प्रमाणं परमाणुसंज्ञम् । Cf. also, बसरेष्वस्तु विशेषः विश्वता परमाणुभिः ।

The magnitude of a Paramánu is called Párimándalya (पारिमान्दल्य) in the Nyáya-Vaiseshika, the name suggesting that the Paramánus were conceived to be spherical in shape. The Nyáya-Vaiseshika calls a Paramánu a mere point without any dimensions, but in the Sáñkhya-Pátañjala, a Paramánu, though indefinitely small, had still dimensions, being divisible into Tanmátras, which were themselves integrations of Bhútádi. The diameter of a spherical Paramánu must have been conceived to be less than 3.2^{-20} of an inch (*i.e.* less than the conventional Paramánu with which linear measures begin), and the volume of a Paramánu would therefore, in accordance with Bhás-kara's formula, be smaller than $\frac{4}{3}\pi.3^3.2^{-63}$ or $\pi.3^2.2^{-61}$ of a cubic inch where $\pi = \frac{3}{1}\frac{9}{5}\frac{2}{5}\frac{7}{5}$. The Tanmátras were conceived as smaller still.

That these were conventional measures arbitrarily assumed goes without question, for, of course, the Hindus had no physical data for a mathematical calculation of these minute quantities. A Bálágra (hair-tip, or finest filament of hair), for example, is taken to be $3\cdot2^{-14}$ of an inch

thick, i.e. less than one five-thousandth fraction of an inch in thickness ; and a fibril of the networks of Dhamaní or Nádí (nerve) that supply the pores of the skin (papillæ ? सुखानि रीमकूपप्रतिव्याख्यानि, Susruta) was supposed to be about a thousandth part of the finest hair in thickness, or $\frac{1}{128}$ of the 'minimum visible', and therefore about $3 \cdot 10^{-32-14}$ of an inch thick (cf. सूक्ष्माणीप्रचारसः रोकः सहजभागेन तुख्यासु प्रचरति, Pañchadasí), but it is evident that these measures were arbitrarily fixed upon, instead of being arrived at by calculation or actual measurement. Indeed, Charaka expressly states that the number of Sírás and Dhamanís in the body (three million fifty-six thousand nine hundred) is only a conjectural estimate अनिहेष्मस्तः परं तर्कमेव—Sárirasthána, Chap. VII).

My account of the chemistry of the Sáṅkhyā-Pátañjala, and of the affiliated Yoga and medical schools, has anticipated in several points the views of the Vedánta and the Nyáya-Vaisesika. The chemical facts, processes and apparatus are indeed common to all the schools. In the following account of the chemistry of the schools other than the Sáṅkhyā-Pátañjala, I will confine myself to the theory of the subject, and even of this I will attempt only the briefest outline.

The Vedántic view :—

The Vedántists believe Mágá to be the 'material cause' (उत्पादकारक) of the world. The power

of Māyā is the power to realise the unreal—to impart practical Reality or mediate existence to that which does not and cannot possess absolute Reality or self-existence. Māyā is at once real and unreal, while the Brahma (Self) is absolute Reality, absolute Intelligence and absolute Bliss. The world evolves out of Māyā (मायापरिणाम) so that Māyā in the Vedānta replaces the Prakṛiti of the Sāṅkhya. But Māyā, and by implication the world, originate out of Brahma, not by a process of evolution (परिणाम), but of Vivarta (self-alienation). The self-alienation of the Absolute, acting through Māyā, produces in the beginning A'kāsa, one, infinite, ubiquitous, imponderable, inert and all pervasive. The world thus begun goes on evolving, in increasing complexity. The other Sūkshma Bhūtas, classes of subtle matter, evolve from A'kāsa, in an ascending linear order,—A'kāsa giving off Vāyu, Vāyu giving off Tejas, Tejas giving off Ap, and Ap giving off Earth. A'kāsa, one, infinite, all-pervasive, has the capacity of sound. Vāyu, subtle gaseous matter, emanates from the universal A'kāsa and is instinct with the potential of mechanical energy (impact, pressure). इरण् प्रणाभिल् वहन् व्युहन्—वायोष सर्वं पेदादेतुलेन सर्वाविनाभूतत्वात्—Vidvanmanorañjinī). Tejas, subtle radiant matter, emanates from Vāyu, and contains in potentia the energy of light and heat.. Ap, subtle viscous matter, is the

transformation of Tejas, and is instinct with the energy that stimulates the nerve of taste, and lastly, Earth, subtile hard matter, which is the transformation of Ap, possesses the latent energy of smell.

But the subtile rudiments of matter must be compounded in various ways, to give rise to the gross constituent matter of the world. These forms of gross matter are called Mahábhútas. There are five kinds of Mahábhúta (gross matter corresponding to the five Súkshma Bhútas (subtile matter, and the process by which a Mahábhúta is produced from the Súkshma Bhútas is called Pañchíkarana (quintuplication). All the five Súkshma Bhútas are present as ingredients, though in different proportions, in each Mahábhúta.

The Mahábhúta Earth, gross earth-matter, is composed of four parts of subtile earth-matter, and one part each of the other forms of subtile matter. The Mahábhúta Váyu is composed of four parts of subtile gaseous matter and one part each of the other forms of subtile matter. And similarly with other Mahábhútas.

Hence if ak, v, t, ap, e, represent the five forms of subtile matter (Akása, Váyu, Tejas. Ap and Earth), and AK, V, T, AP, E, stand for the corresponding Mahábhútas, we may represent the constitution of the Mahábhútas as follows :—

AK = ak₄. (v₁. t₁. ap₁. e₁), ak₄ being the radicle.

V = v₄. (ak₁. t₁. ap₁. e₁), v₄ being the radicle.

T = t₄. (ak₁. v₁. ap₁. e₁), t₄, being the radicle.

AP = ap₄. (ak₁. v₁. t₁. e₁), ap₄ being the radicle

E = e₄. (ak₁. v₁. t₁. ap₁), e₄ being the radicle.

In forms of gross or compounded matter, the potential energies (or qualities) become actualised. The Mahābhūta Akāśa manifests sound ; Vāyu, sound and mechanical energy ; Tejas, sound, mechanical energy and heat-light ; Ap, the energy of the taste-stimulus in addition ; and finally Earth the energy of the smell-stimulus added to the foregoing.

The Pañchadasī characterises the different Mahābhūtas by their typical sounds ; e.g., Akāśa by the echo (hollow booming sound) ; Vāyu (air) by a sibilant sound, hissing, susurration (imitative symbol, Visi) ; Tejas (fire) by a puffing (or roaring) sound (imitative symbol, Bhugubhugu) ; Ap (water) by a liquid sound (imitative symbol Culū Culū, gurgle, plash-plash, glut-glut) ; and finally Earth by a splitting or rattling sound, a crack or a thud (symbol, kad-kada)—Chap. II. Bhútaviveka, S'loka 3, Pañchadasī, cf. also Jayanta, Mañjarī.)

Others hold that Akāśa, Ether, never enters as a component part, and is always one and indivisible. In this view, the four Mahābhūtas—Vāyu, Tejas, Ap and Earth alone are supposed to be com-

pounded, and by a process which may be called quaternion (cf. the Neo-Platonist quaternion) :—

$$V = v_3 (t_1 \cdot ap_1 \cdot e_1)$$

$$T = t_3 (v_1 \cdot ap_1 \cdot e_1)$$

$$AP = ap_3 (v_1 \cdot t_1 \cdot e_1)$$

$$E = e_3 (v_1 \cdot t_1 \cdot ap_1)$$

These compound forms, as before, are supposed to exercise their specific energies actively. Others again hold that the Mahábhútas—Tejas, Ap and Earth alone are compounded by a process named Trivrit-karana (triplication). Thus $T = t_2 (ap_1 \cdot e_1)$, $AP = ap_2 (t_1 \cdot e_1)$, $E = e_2 (t_1 \cdot ap_1)$.

The Súkshma-bhútas are forms of homogeneous and continuous matter, without any atomicity of structure ; the Mahábhútas are composite ; but even these are regarded as continuous, and without any atomic structure. The Vedánta speaks of Anu (Paramánu) not as an ultimate indivisible discrete constituent of matter, but as the smallest conceivable quantum or measure of matter. In the Sánkhya doctrine, the atomic structure is ordinarily accepted. The Gunas are supposed to be परिमित and अपरिमित bounded and indefinitely small in size (except the Gunas giving rise to A'kása and Manas which are unlimited अपरिमित) ; and hence the Tanmátras and Paramánus must be conceived to have a discrete structure.

As I have already noted in my account of the genesis of Tanmátras and Paramánus, various

schools of Vedántists (*e.g.* the Rámánujists and the followers of Nimbárka) combined, in the orthodox fashion of the Smritis and the Puráṇas, the Vedántic theosophy with the Sáñkhya cosmology especially as regards Prakrti and the order of creation and dissolution. For example, the Vedántakaustubhaprabhá, fortifying itself with texts from the Vishnu Puráṇa and the Subala and Gopála Upanishadas, contends that at the cosmic dissolution (Pralaya), each Mahábhúta merges into the one that preceded it in the order of creation by first disintergrating into its own proper Tanmátric form (तन्मात्रहारा), and that the Mahábhúta A'kasa merges into the original Tanmátras, which then lapse into Bhútádi, the supersubtile rudiment matter, proto-matter (Chap. II, Pada 3 Sutra 14).

Parináma—Evolutionary Process:—When the Mahábhútas are once formed, the different kinds of substance are derived from them by the evolutionary process called Parináma (परिणाम, transformation). Matter is constantly undergoing change of state. The effect is only the cause in a new collocation (कारणस्येव रुद्धान्तमात्रं कार्यम्). Change is of two kinds :—

(1) Change by a spontaneous process, without external influence, including isomeric change (खालादिक परिणाम). The Vedantists believe in

thick, i.e. less than one five-thousandth fraction of an inch in thickness ; and a fibril of the networks of Dhamaní or Nádī (nerve) that supply the pores of the skin (papillæ ? सुखानि रोमकूपप्रतिबन्धानि, Susruta) was supposed to be about a thousandth part of the finest hair in thickness, or $\frac{1}{256}$ of the 'minimum visible', and therefore about $3 \cdot 10^{-52-14}$ of an inch thick (cf. सूक्ष्माकृप्रचारतः रोबः सहस्रभागेन तुख्यासु प्रचरति, Pañchadasí), but it is evident that these measures were arbitrarily fixed upon, instead of being arrived at by calculation or actual measurement. Indeed, Charaka expressly states that the number of Sírás and Dhamanís in the body (three million fifty-six thousand nine hundred) is only a conjectural estimate अनिहेष्मस्तः परं तर्कमेव—Sárirasthána, Chap. VII).

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The Vedántic view :—

The Vedántists believe Máyá to be the 'material cause' (उपादानकारण) of the world. The power

of Māyā is the power to realise the unreal—to impart practical Reality or mediate existence to that which does not and cannot possess absolute Reality or self-existence. Māyā is at once real and unreal, while the Brahma (Self) is absolute Reality, absolute Intelligence and absolute Bliss. The world evolves out of Māyā (मायापरिणाम) so that Māyā in the Vēdānta replaces the Prakṛiti of the Sāṅkhya. But Māyā, and by implication the world, originate out of Brahma, not by a process of evolution (परिणाम), but of Vivarta (self-alienation). The self-alienation of the Absolute, acting through Māyā, produces in the beginning Ākāsa, one, infinite, ubiquitous, imponderable, inert and all pervasive. The world thus begun goes on evolving, in increasing complexity. The other Sūkshma Bhūtas, classes of subtle matter, evolve from Ākāsa, in an ascending linear order,—Ākāsa giving off Vāyu, Vāyu giving off Tejas, Tejas giving off Ap, and Ap giving off Earth. Ākāsa, one, infinite, all-pervasive, has the capacity of sound. Vāyu, subtle gaseous matter, emanates from the universal Ākāsa and is instinct with the potential of mechanical energy (impact, pressure). वैरण, प्रणामित्व, वहन, व्युहन,—वायोष सर्वं विद्वान्मनोराजीनि— सर्वाक्षिणाभूतत्वात्—Vidvanmanorajini). Tejas, subtle radiant matter, emanates from Vāyu, and contains in potentia the energy of light and heat. Ap, subtle viscous matter, is the

transformation of Tejas, and is instinct with the energy that stimulates the nerve of taste, and lastly, Earth, subtile hard matter, which is the transformation of Ap, possesses the latent energy of smell.

But the subtile rudiments of matter must be compounded in various ways, to give rise to the gross constituent matter of the world. These forms of gross matter are called Mahábhútas. There are five kinds of Mahábhúta (gross matter corresponding to the five Súkshma Bhútas (subtile matter, and the process by which a Mahábhúta is produced from the Súkshma Bhútas is called Pañchíkarana (quintuplication). All the five Súkshma Bhútas are present as ingredients, though in different proportions, in each Mahábhúta.

The Mahábhúta Earth, gross earth-matter, is composed of four parts of subtile earth-matter, and one part each of the other forms of subtile matter. The Mahábhúta Váyu is composed of four parts of subtile gaseous matter and one part each of the other forms of subtile matter. And similarly with other Mahábhútas.

Hence if ak, v, t, ap, e, represent the five forms of subtile matter (Akása, Váyu, Tejas. Ap and Earth), and AK, V, T, AP, E, stand for the corresponding Mahábhútas, we may represent the constitution of the Mahábhútas as follows :—

$AK = ak_4 \cdot (v_1 \cdot t_1 \cdot ap_1 \cdot e_1)$, ak_4 being the radicle.

$V = v_4 \cdot (ak_1 \cdot t_1 \cdot ap_1 \cdot e_1)$, v_4 being the radicle.

$T = t_4 \cdot (ak_1 \cdot v_1 \cdot ap_1 \cdot e_1)$, t_4 , being the radicle.

$AP = ap_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot e_1)$, ap_4 being the radicle

$E = e_4 \cdot (ak_1 \cdot v_1 \cdot t_1 \cdot ap_1)$, e_4 being the radicle.

In forms of gross or compounded matter, the potential energies (or qualities) become actualised. The Mahábhúta Akása manifests sound ; Váyu, sound and mechanical energy ; Tejas, sound, mechanical energy and heat-light ; Ap, the energy of the taste-stimulus in addition ; and finally Earth the energy of the smell-stimulus added to the foregoing.

The Pañchadasí characterises the different Mahábhútas by their typical sounds ; e.g., Akása by the echo (hollow booming sound) ; Váyu (air) by a sibilant sound, hissing, susurration (imitative symbol, Visi) ; Tejas (fire) by a puffing (or roaring) sound (imitative symbol, Bhugubhugu) ; Ap (water) by a liquid sound (imitative symbol Culū Culū, gurgle, plash-plash, glut-glut) ; and finally Earth by a splitting or rattling sound, a crack or a thud (symbol, kad-kada)—Chap. II. Bhútaviveka, S'loka 3, Pañchadasí, cf. also Jayanta, Mañjarí.)

Others hold that A'kása, Ether, never enters as a component part, and is always one and indivisible. In this view, the four Mahábhútas—Váyu, Tejas, Ap and Earth alone are supposed to be com-

pounded, and by a process which may be called quaternion (cf. the Neo-Platonist quaternion) :—

$$V = v_3 (t_1 \cdot ap_1 \cdot e_1)$$

$$T = t_3 (v_1 \cdot ap_1 \cdot e_1)$$

$$AP = ap_3 (v_1 \cdot t_1 \cdot e_1)$$

$$E = e_3 (v_1 \cdot t_1 \cdot ap_1)$$

These compound forms, as before, are supposed to exercise their specific energies actively. Others again hold that the Mahábhútas—Tejas, Ap and Earth alone are compounded by a process named Trivrit-karana (triplication). Thus $T = t_2 (ap_1 \cdot e_1)$, $AP = ap_2 (t_1 \cdot e_1)$, $E = e_2 (t_1 \cdot ap_1)$.

The Súkshma-bhútas are forms of homogeneous and continuous matter, without any atomicity of structure ; the Mahábhútas are composite ; but even these are regarded as continuous, and without any atomic structure. The Vedánta speaks of Anu (Paramánu) not as an ultimate indivisible discrete constituent of matter, but as the smallest conceivable quantum or measure of matter. In the Sáñkhya doctrine, the atomic structure is ordinarily accepted. The Gunas are supposed to be परिमित and अपरिमित bounded and indefinitely small in size (except the Gunas giving rise to A'kása and Manas which are unlimited अपरिमित) ; and hence the Tanmátras and Paramánus must be conceived to have a discrete structure.

As I have already noted in my account of the genesis of Tanmátras and Paramánus, various

schools of Vedántists (*e.g.* the Rámánujists and the followers of Nimbárka) combined, in the orthodox fashion of the Smritis and the Puráṇas, the Vedántic theosophy with the Sáñkhya cosmology especially as regards Prakrti and the order of creation and dissolution. For example, the Vedántakaustubhaprabhá, fortifying itself with texts from the Vishnu Puráṇa and the Subala and Gopála Upanishadas, contends that at the cosmic dissolution (Pralaya), each Mahábhúta merges into the one that preceded it in the order of creation by first disintergrating into its own proper Tanmátric form (तन्मात्रद्वारा), and that the Mahábhúta A'kasa merges into the original Tanmátras, which then lapse into Bhútádi, the supersubtile rudiment matter, proto-matter (Chap. II, Pada 3 Sutra 14).

Parináma—Evolutionary Process:—When the Mahábhútas are once formed, the different kinds of substance are derived from them by the evolutionary process called Parináma (परिणाम, transformation). Matter is constantly undergoing change of state. The effect is only the cause in a new collocation (कारणस्येव रुख्यान्तमात्रं कार्यम्). Change is of two kinds :—

(1) Change by a spontaneous process, without external influence, including isomeric change (खालादिक परिणाम). The Vedántists believe in

spontaneous disintegration and reintegration. Action from without, impressed force *ab extra*, is not, *pace* the Naiyáyikas, always a condition of change of state (whether of rest or of motion);— nor is it necessary that more than one substance should combine to generate another substance or variety of substance (e. g. the formation of curds from milk, of ice from water etc.). All this is directed against the Nyáya doctrine (A'rambhaváda).

(2) Change due to combination with other substances (द्रव्यात्मकसंयोग). Such combination may produce (1) a compound substance possessing like qualities with the constituents (समानजातीयोत्पत्ति), or (2) unlike compounds with new qualities, “heteropathic effects” (विजातीयोत्पत्ति). Any new quality thus evolved through (chemical) combination is called Samhata-bhúta-dharma (संहतभूतधर्म), e. g. the intoxicating power of the fermented rice and molasses, which does not exist in the ingredients taken separately. (नद्यवौलाना प्रत्येकं चवर्णमालापि समुदायशक्ता महस्ति: हस्तते). This Sambhúyakriyā (समूच्यक्रिया, समुत्त्वान्) corresponds to chemical combination, and the Vedantists, like the Sánkhyas, explain this only as the evolution of the latent energy (शक्ति, असुहृत्प्रकृति) in a new collocation (संस्थापन, अवयव-स्थिरिष्ठ). But, unlike the mediæval Sánkhya, the Vedánta freely recognises the com-

bination of heterogeneous Bhútas. Thus, Earth, Ap, Tejas and Váyu freely combine in different proportions and groupings to produce the variety of substances in the world. For example, the animal organism is a compound of all the five Bhútas (पात्रभौतिक). It is not merely the concomitant or efficient causes that may be heterogeneous to the material cause, as the Naiyáyikas contend, but several heterogeneous substances or (Bhútas) may unite as 'material causes' to produce a new substance.

The Vedantists resolve all activity, physical, vital as well as psychical, into modes of motion, subtle cosmic motion (परिस्थन्द, सर्वलोकपरिस्थन्द—S'aṅkara ; वायोः परिस्थन्दामकलात्,—प्राणस्त परिस्थन्दामकलादेव—यदृचं स्तुतं सूक्ष्मं च तत्त्वं मनःप्रकृतमात्रम्—S'aṅkara); but they give a separate substantive existence to the agents, the vital principle (प्राण) and the mind (मनः), though these are also evolutionary transformations of the Súkshma Bhútas (forms of subtle matter). What is common to the Nyáya, the Vedanta and the Sánkhya is that Consciousness or Intelligence (ज्ञान) transcends Matter; but the Naiyáyikas as pluralists hold that vital and psychical activities are also immaterial and cannot be resolved into motion (परिस्थन्द);—the Vedántists resolve these activities into subtle motion, but

ascribe them to a substantive quasi-material Life Principle and Mind, the all-mirroring Intelligence (चेतन्य) alone being immaterial and transcendent : and the Sāṅkhyas accept the substantive existence of the Mind principle (मनः) as derived co-ordinately with the Súkshma Bhútas or Tanmátras from individualised prakriti (Ahaṅkára), but resolve Life into a mere resultant activity of the bodily organs, viz. the organs of sense and movement, and the psychic principle (मनः).

पञ्चीकरण :—धिधा विधाय चैकैकं चतुर्ज्ञा प्रथमं पुनः ।

स्वस्वेतरदितीयांशैर्थोऽनात् पञ्च पञ्चते ।

यधा विसर्गशुतौ स्फटानां भूतानां स्फुटतरव्यवहारनामकपस्य करणी-
पायतया विडृकरणं श्रुतं तदृतं भूतपञ्चकसर्गशुतौ अपि तथा । तदानौ
पञ्चीकरणान्तरं आकाश शब्दोऽभिव्यज्यते स्फुटतयेति सर्वव योजनीर्यं
(विहन्मनोरंजिनी) —अस्ति हि श्रौरैरे सर्वेषामपि भूतानां कार्य-
संप्रतिपत्तिः अवकाशश्चूङ्कनपदनहै देनकाठिन्यानां सर्वजनानुभवसिद्धत्वात् ।
अतस्तत्कारणतया पञ्चाणि भूताणि पक्षाणि देहे सन्तीति स्थिते
तनुपटयोरिव अवयवावयवित्वमेव पञ्चभूतदेहयोर्युक्तं । न च अर्जशून्यत्वात्
एकद्रव्यत्वात् च आकाशस्य आरम्भकलानुपपत्तिरिति वाच्यं । आरम्भ-
वादस्य अनज्ञीकारात् । एकस्यापि दुष्कावयविनी दध्यारम्भकलदर्शनात् ।
वस्तुपञ्च पञ्चानां भूतानां पञ्चामकलत्वं दर्शितत्वात् आरम्भवादस्य
गिराङ्कतत्वात् च । तत्त्वात् सिंहं श्रौरैरपाञ्चमौतिकमिति । Vidvan-
manorañjinī.

न तापत् समानजातीयसेव आरभते न भिद्धजासीथनिःत नियमो
नाहि । समवायिकारण्ये एव समानजातीयत्वाभ्युपगमः न कारणात्मर-
विषय इति तदपि अनेकान्तिकम् । नापि अनेकसेव आरभते नैकमिति
नियमोऽहि । अणमनसीराद्यकर्त्त्वारभ्युपगमात् । एकैको हि परमाणु-
शादं स्वकर्त्त्वारभते न द्रव्यात्मरैः संहस्र इत्यभ्युपगम्यते । द्रव्यारण्ये एव
अनेकारक्तत्वनिधम् इति चेत् न परिणामाभ्युपगम्यते । तत्त्वं कर्त्तिर्
अनेकं परिणमते सूक्ष्मज्ञानुरादिभावेन, कर्त्तिर्देवं परिणमते चौरादि-
दध्यादिभावेन । नेत्ररश्वासनं अस्ति अनेकं पव कारणं कार्ये लब्धति
इति ! Sāṅkara, Sáriroka bháshya, Sútra 7. Pada 3,
Adhyáya II).

The atomic theory of the Buddhists :—The Vaibháshikas and the Sautrántikas hold that the Váyu-atoms are touch-sensibles, having impact or pressure for their characteristic property, and by aggregation from the element Váyu ; the Tejas-atoms are colour-and-touch-sensibles, having heat for their characteristic, and by aggregation from the Tejas Bhúta ; the Ap-atoms are taste-colour-and-touch-sensibles with a characteristic viscosity, and form the Ap-element by aggre-gation ; and finally the Earth-atoms are smell-taste colour-and-touch-sensibles possessing a characteristic dryness or roughness (खरत), and by their aggregation form the Earth-element. The Bhútas

thus originated combine to form aggregates, which are classed as inorganic substances, organisms and organs. (कामेऽदद्वयकोऽचुः—Udyotakara's extract from the Buddhist Sútras, Nyáya Vártika. Chap. I. A'hnika 1, Sútra, 14. cf. Váchaspati's fuller extract :—
 कामे अद्वयकोऽसरवदः सप्तातुरसपवातुः कामधातुः—also the Buddhist commentary :—कामे कामधातौ अद्वयकः चचुः। सप्तसगम्भार्य इति चलारि द्रव्यादि पृथिव्यपृतेजीवायुः इति चलारि—Váchaspati. Tátparyyaśíká, loc. cit.—also सरबेहोण्ठेरण्सभावानि मूर्तानि—*vide* Udyotakara, Chap. III, A'hnika 2, Sútra 12,—*Vide* also Sríñivása's Vedánta-kaustubha, Chap. II, Pada 2. Sútra 18).

The atomic theory of the Jainas :—Of the nine categories of the Jainas, that of Ajíva, (the not-soul or non-Ego) consists of five entities, four of which are immaterial (अमूर्त), viz., merit, demerit, space and Time, and the fifth, material (मूर्त, possessing figure). The last is called Pudgala (matter), and this alone is the vehicle of Energy, which is essentially kinetic, i.e. of the nature of motion. Everything in the world of not-soul (the non-Ego) is either an entity (द्रव्य), or a change of state in an entity (पर्याय). Pudgala (matter) and its changes of state (पर्याय), whether of the nature of subtle motion (परिच्छन्द) or of Evolution (परिवाप्त), must furnish the *physical* as opposed to the *metaphysical* basis of all our explanations of Nature. Pud-

gala (Matter) exists in two forms,—Anu (atom) and Skandha (aggregate). The Jainas begin with an absolutely homogeneous mass of Pudgalas, which, by differentiation (सेव) breaks up into several kinds of atoms qualitatively determined, and by differentiation, integration, and differentiation in the integrated (संचातात्, भेदात्, संचात्भेदात्—Umásvátí, Chap. V, Sútra 26), forms aggregates (Skandhas). An Anu has no parts, no beginning, middle or end. An Anu is not only infinitesimal, but also eternal and ultimate. A Skandha may vary from a binary aggregate (द्वयक) to an infinitum (अनन्ताद्युक्त). A binary Skandha is an aggregate of two Anus (atoms), a tertiary Skandha is formed by the addition of an atom (Anu) to the binary (द्वयक) and so on *ad infinitum*. The ascending grades are (1) what can be numbered (संख्य), (2) indefinitely large (असंख्य), (3) infinity of the first order (अनन्त), (4) infinity of the second order (अनन्तानन्त), and so on.

General Properties of Matter :—

The specific characters of the Pudgalas (Matter) are of two kinds, (1) those which are found in atoms as well as in aggregates, and (2) those which are found only in aggregates. Qualities of touch, taste, smell and colour come under the first head.

The original Pudgalas being homogeneous and indeterminate, all sensible qualities, including the infra-sensible qualities of atoms, are the result of evolution (परिवाप्तम्). Every atom thus evolved possesses an infra-sensible (or potential) taste, smell and colour, (one kind of each) and two infra-sensible tactile qualities, e.g. a certain degree of roughness or smoothness (or dryness and moistness ?) and of heat or cold. Earth-atoms, Ap-atoms, etc. are but differentiations of the originally homogeneous Pudgalas. The tactile qualities (खर, वेष्ट, उच्च, शौन) appear first, but qualities of taste, smell and colour are involved in the possession of tactile qualities. An aggregate (Skandha), whether binary, tertiary or of a higher order, possesses (in addition to touch, taste smell, and colour) the following physical characters :—(1) sound, (2) atomic linking, or mutual attraction and repulsion of atoms, (3) dimension, small or great, (4) figure, (5) divisibility, (6) opacity and casting of shadows, and (7) radiant heat and light.

Sensible qualities. Tactile qualities are of the following kinds—hardness or softness, heaviness or lightness (degrees of pressure), heat or cold, and roughness or smoothness (or dryness and viscosity ?). Of these, the atoms (Anus) possess only temperature, and degrees of roughness or smoothness, but

all the four kinds of tactile qualities in different degrees and combinations characterise aggregates of matter from the binary molecule upwards. The Jainas appear to have thought that gravity was developed in molecules as the result of atomic linking. Simple tastes are of five kinds,—bitter, pungent, astringent, acid and sweet. Salt is supposed by some to be resolvable into sweet, while others consider it as a compound taste. Smells are either pleasant or unpleasant. Mallishena notes some elementary varieties of unpleasant smell, *e.g.* the smell of asafœtida, ordure, etc. The simple colours are five—black, blue, red, yellow and white. Sounds may be classed as loud or faint, bass (thick) or treble (hollow), clang or articulate speech.

The most remarkable contribution of the Jainas to the atomic theory relates to their analysis of atomic linking, or the mutual attraction (or repulsion) of atoms, in the formation of molecules. The question is raised in Umásváti's Jaina Sútras (circa A. D. 40)—what constitutes atomic linking ? Is mere contact (or juxtaposition) of atoms sufficient to cause linking ? No distinction is here made between the forces that bind together atoms of the same Bhúta, and the chemical affinity of one Bhúta to another. The Jainas hold that the different classes of elementary substances (Bhútas) are all evolved from the same primordial atoms.

The intra-atomic forces which lead to the formation of chemical compounds do not therefore differ in kind from those that explain the original linking of atoms to form molecules.

Mere juxtaposition (संयोग) is insufficient; *linking* of atoms or molecules must follow before a compound can be produced. The linking takes place under different conditions. Ordinarily speaking, one particle of matter (शब्द) must be negative, and other positive (विषमवृच्युता); the two particles must have two peculiar opposite qualities, roughness and smoothness (रुक्षता and क्रिप्तता or dryness and viscosity?), to make the linking possible. But no linking takes place, where the qualities, though opposed, are very defective or feeble (जाप्तवृच्य). We have seen that, ordinarily speaking, two homogeneous particles, i.e. both positive, or both negative, do not unite. This is the case where the opposed qualities are equal in intensity. But if the strength or intensity of the one is twice as great as that of the other, or exceeds that proportion, then even similar particles may be attracted towards each other. In every case, change of state in both the particles is supposed to be the result of this linking, and the physical characters of the aggregate depend on the nature of this linking. When particles of equal intensity (negative and positive) modify each

other, there is mutual action ; in cases of unequal intensity, the higher intensity transforms the lower, it being apparently thought that an influence proceeds from the higher to the lower. All changes in the qualities of atoms depend on this linking. A crude anticipation this, of the ionic theory of chemical combinations, very crude but immensely suggestive, and possibly based on the observed electrification of smooth and rough surfaces as the result of rubbing. The interpretation of रस and लिङ्ग as dry and viscous (or as vitreous and resinous ?) must be rejected in this connection as untenable. The Tattvárdhígama of Umásvátí, which expounds the theory, most probably dates back to the first half of the first century A. D. Cf. Umásvútí—Tattvárdhígama, Chap. V.

(अत्रोपकाशा चर्याधर्माकाशपुङ्गलाः । द्रव्याणि औबाष । नित्या-
वस्थितानि अष्टपाति । रूपिणः पुङ्गलाः । आकाशादेकद्रव्याति ।
नित्युपाति च । पुदगलजीवास्तु क्रियावनः । (क्रियेत गतिकर्त्त्वात्) ।
सर्वेषां प्रदेशाः सत्ति अन्यच परमाण्योः । संख्येयासंख्येयाश पुदगलानां ।
नाशोः । स्पर्शरसगत्वर्थवनः पुदगलाः । तत्र सर्वोऽपविधः कठिनो
मदुर्गुरुर्बहुः श्रोत उच्चः लिङ्गः रस इति । रसः पञ्चविधकितः
कटुः जलायोऽजलो मधुर इति । गन्धो दिविषः सुरभिरसुराभय । वर्षः
पञ्चविधः लक्षो नीलो लोहितः योतः यज्ञ इति ।

अद्वयमसौचाक्षौचासंस्कारमेदत्मन्यायातपीडीतवक्ष । तत्र अद्वः
पञ्चविधः वस्ति वितती चनः शशिरी वर्णो भाव इति । अच्छः

खन्धाश । उक्तं च । कारणमेव तदन्त्य तु ज्ञानो निवाप भवति परमाणुः ।
एकरसगम्भवणौ हिस्यर्थः कार्यत्विद्वाश । तदाशब्दोऽवृहाः स्खन्धाशु वदा-
एव । स्खन्धाशावत् संघातमेदेभ्य उत्पद्यन्ते । संघातमेदादिति । इयोः
परमाणुः संघाताद्विप्रदेशः । हिप्रदेशस्थाशीश संघातात् विप्रदेशः ।
एवं संख्येयामासंख्येयामासनन्तानां अनन्तामन्तानां च प्रदेशानां
संघातात् प्रदेशाः । भेदादप्याः । भेदादेव परमाणुरुक्तपद्यते न
संघातादिति । अवाह । किं संयोगमात्रादेव संघाती भवति ।
आहोस्त्रिदलि कश्चिद्विशेष इति । अतोच्यते । सति संयोगे वज्रस्य
संघाती भवतीति । स्त्रिगच्छक्षत्वाद्यः । न अध्यगुणानाम् । चिग्न-
क्षयोः पुद्गलयोः स्त्रियोर्बन्धी भवतीति । अध्यगुणस्त्रिग्धानां
अध्यगुणक्षत्वाणां च परस्परेण वन्धी न भवतीति । उक्तं भवता
अध्यगुणवर्जनानां स्त्रिग्धानां क्षये ददाणां च स्त्रिग्धेन सह वन्धी
भवतीति । अथ तु ल्यगुणयोः किमत्यन्तप्रतिक्षेप इति । अतोच्यते ।
न । गुणसाम्ये सहशानां । गुणसाम्ये सति सहशानां वन्धी न भवति ।
तदृष्ट्या । तु ल्यगुणस्त्रिग्धस्य तु ल्यगुणस्त्रिग्धेन तु ल्यगुणक्षत्वस्य तु ल्यगुण-
क्षये इति । अवाह सहशयह्यः किमपेचते इति । अतोच्यते ।
गुणवैवन्धे सहशानां वन्धी भवति इति । अतोच्यते । उपचिकादिगुणानां
तु उपचिकादिगुणानां सहशानां वन्धी भवति । रिगुणाद्युपचिकादिग्धेन ।
रिगुणाद्युपचिकादिग्धेन । उपचापि रिगुणाद्युपचिकादिग्धेन
क्षये । एकादिगुणाद्युपचिकादिग्धेन सहशयवन्धी न भवति । अवाह
परमाणुरुक्तस्य स्त्रेण च वै अर्द्धाह्यो बुधादे किं अवस्थिताः विदु

आहोऽिद्यवस्तिं इति । अत्रोच्चते । अव्यवस्थितायुतः । परिचामान् । अवाहं इयोरपि वस्त्रानयोग्यवस्थे सति वर्णं परिचामो भवति इति । उच्चते । वस्ते समाधिकी पारिचामिकौ । वस्ते सति समग्रवस्त्रं समग्राः परिचामको भवति । अधिकगुणी होत्येति । Umásváti, Tattvárthádhigama, Chap. V).

The Nyáya-Vaiseshika chemical theory : a brief summary.

I must content myself here with a brief and rapid sketch of the chemistry of the Nyáya-Vaiseshika, which I shall elaborate in connection with the mechanics and physics of the ancient Hindus in a separate paper.

The relation of the specific characters of molecules (and higher aggregates) to the original atomic qualities is reduced in the Nyáya-Vaiseshika to the following canons :— (a) कार्यगुणं कारचगुणं पूर्वकम् । (b) स्त्रानजातीयसंयोगः इव्यारक्षकः न विजातीयसंयोगः (Here, इव्य is used in a narrow technical sense, so as to exclude the quasi-compound sub-stances). (c) अपाकाङ्क्षपरसगच्छर्परिमाणेकलैकपृथक्गुह्यत्रिवलकोइवेगः कारचगुणपूर्वकाः । (d) एपरसगच्छर्परिमाणेकलैकपृथक्गुह्यत्रिवलकोहाः स्त्रानजातीयारक्षकाः । No spearate explanation is necessary, as the canons are embodied in the following exposition.

Theory of Atomic combination :—

The four kinds of Atoms are Earth, Ap, Tejas and Váyu atoms, possessed of characteristic mass, numerical unit, weight, fluidity (or its opposite), viscosity (or its opposite), velocity (or quantity of impressed motion—Vega); also characteristic potential colour, taste, smell or touch, not produced by the chemical operation of heat चपाक्षण-क्षयसम्बन्धपरिमाणे कल्पे क-पृथक्-गुदत्वद्वयत्वे इति गः). A 'kasa has no atomic structure (निरवय), and is absolutely inert (निरच्छ्रव), being posited only as the substratum of sound, which is supposed to travel wave-like in the manifesting medium or vehicle of Váyu (air). Only the other four Bhútas unite (or disunite) in atomic or molecular forms. The orthodox view is that, the presence of Earth-atoms is necessary whenever chemical transformation under the operation of heat (पात्रजोत्पत्ति) takes place.

Atoms cannot exist in an uncombined state in Creation (Sivádityá, Sapta-padárthí—*Vide* commentary, where, however, it is noted that still atmospheric air is believed to be monatomic in structure, i. e. to consist of masses of atoms in a loose uncombined state—(चक्राभवायुसु परमाक्षुसमूह एव चनारव्य-इत्यः ।

The atoms may combine in one or other of the following ways :—

1. One Earth-atom, by an original tendency, unites with another, to form a binary molecule (द्वयुक्). In the same way, binary molecules of the other Bhūtas are formed. The atoms are possessed of an inherent Parispanda (rotary or vibratory motion), and when they unite in pairs, *so long as there is no chemical operation under the action of heat corpuscles*, the original qualities of the atoms produce homogeneous qualities in the binary molecules.

The question as to the existence of a triad, a tetrad, a pentad etc. of atoms is one of the moot points of the Nyāya-Vaisesika. The orthodox view is that, the primordial infinitesimal particles (atoms) start with an incessant vibratory motion अनवरतपरिच्छमानापरिमितपद्धतिः, Raghunātha S'iro-mani—गतिश्चोक्त्वात् पद्धतिपद्धतिः पद्धतिः, Udayana, Kusumāñjali), and an inherent impulse that drives them to unite in pairs—a sort of 'monovalency', *as it were*, exhausted with the formation of a binary molecule. The binary molecules now combine by threes, fours, fives, etc. to form larger aggregates as well as the variety of elementary substances, the particular collocation in any case being not only determined by physical causes, but also serving to satisfy the ends of the moral Law in creation (चड्ड, चर्च), (द्वयुक्तेषुभिरात्मते चलयि निवासी,

न वाच्या । चहुषु लभितमः । कदाचित् विभिरारभते इति । वाचुकमित्युच्चते, कदाचिच्चतुर्मिरारभते कदाचित् पञ्चमिरिति यदेष्टं कल्पना । चहुषवशात् तथा तथा तेषां चूडी यथा यथा तदारब्धेषु चप्रज्ञातयी अव्याप्ते । चहुषकारिता सर्वभावानां छटिः । S'ridhara, Nyáya-Kandálí, पृष्ठिवीनिकपञ्चम् ।) Cf. Váchaspati's report, Bhámatí, Chap. II., Pada II. Sútra II. यदा चतुरणुकमारभते चतुर्णां वाचुकागामारभकल्पात् । Prasastapáda appears to have originated this view (परमाच्छारणुकेषु चहुतसंख्या तैरारभे वाचुकादिलक्षणे—Prasastapáda, परिमाण निरूपञ्चम्) ; but that another view was also maintained in the Vaisesika School is evident from the brief summary of Kanáda's system given in Utpala's commentary on the Vrihatsamhitá, and this indeed also follows from S'ridhara's admissions in the Kandalí. On this view, also, atoms have an inherent tendency to unite, but some unite in pairs, others in triads, others in tetrads, etc. This may happen in two ways,—either by the atoms falling into groups of threes, fours, etc. direct, or by the successive addition of one atom to each preceding aggregate.

A triad (Tryanuka), then, holds together three atoms (Anus), not three binary molecules (Dvyanukas) as on the orthodox hypothesis. Similarly with tetrads, pentads etc. चतुर्विधाः परमाच्छवः चितिकल्पादित्यायुनाम् ।

हात्या परमाणुभां इण्डकमारभ्यते चिभिः परमाणुभिस्त्रृण्डकमारभ्यते इति
क्लेश स्थूलकार्य-द्रव्यस्तोतपर्पतः । Utpala, Chap. 1, S'loka 7 ;
cf. also S'rídhar'a's admission, अथवा यदि परमाणुवी इण्डक-
मारभ्य तत्प्रहितास्त्राणुकमारभने चाणुकसहितान्तु द्रव्यान्तरम् तथापि कुतो
विश्वस्य अयहश्चम् । S'aṅkara seems to speak of two binary
molecules in the Vaisesika as forming a tetrad,
(यदापि हे इण्डके चतुरण्डकमारभेते—S'áriṛaka-Bháshya, Chap.
II, Pada Sútra, II, where the Bhámantí gives a forced
interpretation).

In Prasastapáda's view, these binary molecules
are grouped by threes, fours, fives etc. (त्रयक, चतुरण्डक)
to form different isomeric modifications. The variety
of Earth-substances is due to differences in the
arrangements of the molecules (e.g. their greater or
less density, and, above all, their grouping or collo-
cation व्युह, अवयवसंज्ञिवेश), which account for the speci-
fic characters (अपरजाति) manifested by these iso-
meric substances. या पृथिवी च स्त्रेयाद्यवयवसंज्ञिवेशविशिष्टा
अपरजातिवहुतीयेता । Prasastapáda, पृथिवीनिक्षपणम् । स्त्रेये
निक्षिप्तम् । आदिग्रन्थात् प्रशिद्यत्वादिपरियहः । परमाणवादिपु
अपरजात्यभावेऽपि अष्टष्टवशात् तथा तथा तेषां व्युहः यथा यथा तदारब्धेतु
अपरजातयो व्यज्जने । S'rídhar'a, Kandali, *ibid.*

स्त्रेये व्यिरता विरकातावस्थायित्वमिति यावत् । आदिग्रन्थादिग्रन्थकलं
अकादिग्रन्थहविरोधितत्वं । अवयवसंज्ञिवेशाः तत्तत्सामान्यविशेषाभिव्यक्त-

संस्कारणिकेयाः । न हि एतद्द्रव्यान्तरे सम्भवः । अवाहीनां वत्तिष्ठित्-
स्वरूपद्वयनवद्द्रव्योपग्रियात्मादेवेद महुरत्मात् । Udayana, Kiranā-
vali, *ibid.* These original differences in molecular
grouping leading to distinctions of genera and species,
however mechanically or physically explained, come
also under the operation of moral and metaphysical
causes (चर्त्त, कर्त्त), i.e., of ideal ends in the moral
government of the universe, which are superimposed
upon the physical order, but which do not come
within the scope of Natural philosophy. An elemen-
tary substance thus produced by primary atomic com-
bination, may, however, suffer qualitative change
under the influence of heat (पात्रजोत्पत्ति). The pro-
cess is as follows :—(1) the impact of heat corpuscles
decomposes the binary (tertiary, or quaternary) mole-
cules into homogeneous atoms possessing only the
generic characters of the Bhūta concerned ;—(2) the
impacts of heat particles continue, and transform the
characters of the atoms; determining them all in
the same way ;—(3) the heat particles continue to
impinge, and reunite the atoms so transformed to
form binary (or other) molecules, in different orders
or arrangements, which account for the specific
characters or qualities finally produced. The Vaise-
shika holds that there is decomposition into

homogeneous atoms, transformation of atomic qualities, and finally recombination, all under the influence of heat. The Nyāya on the other hand thinks that the molecules and larger aggregates assume the new characters under the influence of heat without decomposition into homogeneous atoms, or change of atomic characters (पिलुपात्र or पिठरपात्र).

तेषामनुभावेन विभावः परिकल्पते । सर्वावयवेषु असर्वहित्या तातपूर्वकपूर्वकपादिविशब्दगुणोपज्ञवद्देवतःप्रवेशः इत्यानीरनुभीषते तेज विगवता वहिद्वयेष जीदनात् अभिवातात् वा न्तु चटायारथकेषु अवशेषु विभा आयते विभाती विभागः विभागात् इत्यारथकसंबोधविभावः । तदित्यावात् इत्यविभावः । पक्षाव आमादिगुणानवजहतः रक्षादिगुणावरद्वयमनुभवतः—भद्रप्रथमाद्वाः परम रं संयुक्त इत्युक्तादि-प्रक्षमेष ताहम्बलेष चटादिकार्द्वामरमले । एवं तपनातपहम्बमानेषु आवादिफलेषु एव एव व्यावः अरीते वपि उद्येष तेजसा पचमानेषु अप्यपालादिषु रसमस्थानुभावेन परिशामनुपगच्छत्तु प्रायेष प्रतिच्छ-मुलपादिवाङ्गी संभवत इति । (Jayanta, Nyāyamāñjarī—सूतपैदव-पूर्वपत्र). This is the Vaisesika view, but Jayanta himself inclines to the opposite view :—
भद्रतद्विरतवेष आव्यादवक्तव्य चटादिः चारथात् असर्वेषः इत्यानुभवेष्वाक-पादोपयमेः चर्व विभावक्तव्यवदा । विठरपादपत्र एव पेषतः । ibid.
The Nyāya view :—य वीजाववादे पूर्ववृहपरिवावेन

व्युहान्तरमापद्यते व्युहान्तरापक्षी च पृथिवीधातुरव्याप्तिः संयुक्त
आनन्देण तेजसा पञ्चमानो रसद्रव्यः निर्वर्त्यति स रसः पूर्वावयवसहितो-
इहुरादिभावमापद्यते। परमाणुस्थानि वीजानि भवतीत्येतत्र प्रतिपदामहि।
यस्याञ्छास्यादिवैज्ञानिक्यनावस्थामादिं क्लत्वा यावदुपास्तं आलिकौजकाव्ये
तावद्व कदाचित् परमापवश्यं भवति। यदि तु स्यात् कदाचित् वीपलम्येतः।
Udyotakara, Chap. III, A'hnika I, Sútra 4.

11. Chemical combination (संयुक्तिया, संहतकिया).
Chemical combination takes place either between
two or more substances which are isomeric modifi-
cations of the same Bhúta, or between substances
which are modes of different Bhútas.

A. Mono-Bhautic compounds. The simplest
compounds are Mono-Bhautic compounds,
i. e. compounds of different substances
which are isomeric modes of the same
Bhúta.

(a) Mono-Bhautic compounds of the first
order :—Under the impact or impulse
(अभिवात or नीदन) of heat corpuscles, the
substances in chemical contact (चारण्यक
संयोग) break up into their atoms. These
atoms are homogeneous, possessing only
the original physical and chemical charac-
ters of the Bhúta concerned. As the speci-

fic differences between isomeric substances arise from the arrangement or collocation of the atoms, the substances lose their distinctive marks on decomposition into the latter.

(न च परमाणुषु अपरजातिमेदो विष्टते न च
यद्योजशास्त्रिवैतपरमाणुना कविद्विशेषः ।

Uddyotakara, Chap. III, Añnika I,
Sútra 4. न च शक्तीस्तपरमाणुना कविद्
विशेषः पार्थिवत्वाविशेषात् । Sírdhara, Nyáya-
Kandálí, दृष्टिगतिकथम्) । Under the
continued impact, (or, it may be,
impulse) of heat particles (वेगवता वृह-
द्रव्येष जीदनात् अभिधातात् वा—Jayanta),
these atoms take on new charac-
ters. It is heat and heat alone that
can cause this transformation of the
colours, tastes, smells, etc., in these
original Bhúta-atoms. What parti-
cular colours, tastes, smells or physi-
cal characters will be produced in the
atoms depends (1) on the nature
of the constituent substances in con-
tact, (2) the intensity or degree of
the heat (ऊर, ऊदु or मध्यम पात्र), and
(3) the species of Tejas-corpuscles

the impinge on the atoms, or the nature of the impact (विश्वस्तेजः-संयोग). (न द्रूमोद्धिसंबीकात् एकाकात् उपादय इति चपि तु पूर्वउपादिविशेषापेकात् । यदद्रव्यं पञ्चते अधिसंबीकेत् तत्त्वे ये पूर्वउपादयते चां च मनसो विशेषसमपेक्षात् । अधिसंबीकोः उत्तरात् उपादीन् विश्वानामभवते । *Vide also Uddyotakara III, 2, Sútra 14. Cf. also Váchaspati, I, 1, Sútra 4.* अकाक्षमभिर्दै चपि उपादानस पिठरस चौचापरास्तस च वक्षिरुंबोगस पूर्वउपादिपञ्चसाकां आरण्याणां मेहात् भिन्नजातीया जायन् गन्धकपरस्पर्यर्था इति सिद्धान्तः) ।

Now when the atoms have all been determined in the same way, they begin to recombine again under the impact (or impulse) of the heat-particles in binary molecules, (or tertiary, etc.), and these in higher aggregates. It seems to be generally held that, at the final step one or more atoms of one constituent substance unite with one or more atoms of the other constituent substance or substances to form a molecule of the com-

pound ; but the question is not of much significance for Mono-Bhautic compounds of the first order, as, in these cases; the atoms have before this all lost their distinctive characters and become homogeneously transformed. The compound so produced will possess the new characters of the transformed atoms, so far as taste, colour, smell, etc. are concerned, but as the molecular arrangement or structure (अङ्ग, अवयवसंग्रहित) may vary, different compound substances may result from the same components.

- (b) Mono-Bhautic compounds of higher orders :—Again, Mono-Bhautic compounds of the first order may chemically combine to form higher compounds, and as the ultimate Bhúta substratum is the same, the process of decomposition and recombination will be essentially the same as before. The only doubtful point is whether in this case the component compound substances are broken up only into their constituent molecules, or into the original homogeneous Bhúta atoms. Some of the later Vaisesika Scho-

liasts hold that the latter happens in every case of chemical composition, however complex, but the earlier Vaisesika conceived that in the case of compounds of compounds, the decomposition does not proceed so far as the original Bhúta atoms ; but that it is the specifically determined atoms constituting the molecules of the component compounds that are transformed under the impact of the heat-corpuscles ; and then one such transformed atom (one or more according to another version) from the molecule of one component unites with one similarly transformed atom (one or more according to the other version) from the molecule of the other component. Prasastapáda, the great Vaisesika Doctor, holds this view. When, for example, in the fertilised ovum, the germ and the sperm substances, which, in the Vaisesika view, are both isomeric modes of Earth (with accompaniments of other Bhútas), unite, both are broken up into homogeneous Earth-atoms, and it is these that chemically combine under the animal heat (and bio motor

Energy, वायु) to form the germ-plasm (कल्पस). But, next, when the germ-plasm develops, deriving its nutrition from the chyle (blood) of the mother, the animal heat breaks up the molecules of the germ-plasm into its constituent atoms (कल्पारथक-परमाणुः), i.e., into atoms specifically determined, which by their grouping formed the germ-plasm, and then these germ-plasm atoms as radicals chemically combine with the atoms of the food constituents, and thus produce cells and tissues. (समुत्पदाकर्त्तैः कल्पारथकपरमाणुभिः चहृष्टवशात् उपजातक्रियैः पाहारपरमाणुभिः सह सच्चय श्रीरामरमारथते इत्येषा कल्पना। पितुः शकं मातुः श्रेष्ठिं तथैः सन्निधातानन्तरं जठरानलसम्बन्धात् शुक्रशोषितारथकेषु परमाणुषु पूर्वद्वयादिविनाशे सति समानगुणान्तरोत्पत्तौ वाचकादि-प्रक्रमेण कल्पारथश्रीरोत्पत्तिः। तत्र मातुराहाररसः मादया संक्रामति चहृष्टवशात् तद्रु पुरुषोऽरागवसम्बन्धात् कल्पारथकपरमाणुषु क्रियाविभागादिविनाशेन कल्पारथश्रीरोत्ते समुत्पदाकर्त्तैः कल्पारथकपरमाणुभिः चहृष्टवशात् उपजातक्रियैः

प्राहारपरमाणुभिः सह सर्व ग्रीष्मकारमारभते
इतेषा कल्पना । Sridhara, Kandali,
पृथिवीनिष्ठपदम् ।) In this hypothesis
(कल्पना), it is assumed that the
atoms are similarly transformed, i.e.,
become endowed with the colour,
taste, smell, etc. of the product (the
cell or tissue), the moment before
the chemical combination takes place.
Similarly, when milk is transformed
into curd, one view is that the trans-
formation takes place (under internal
heat) in the constituent atoms of
the milk molecules, atoms specifically
determined as milk, and not in the
original atoms of the Bhûta (or Bhutas)
entering into composition of milk.
(Cf. एवं महादुष्कारमः परमाणुभिरेव दधा-
रभते । एषमहिष्वेव दधारमः भैरव पर-
माणुभिर्नवीतारभः इति दिक् । Nyaya-
bodhinî, on Annaim Bhatta's Tarka-
saṅgraha.) Cf. Dinakarî, on the other
hand—दधारमः उपदृश्य दधारमः समव्यवेद्यि तस्म (दधः) ।
In these cases, the atomic contact
is called constituent contact

(आरभात्कर्सयीग), and all the atoms are equally regarded as material causes (उपादानकारक or समवायिकारक) of the compound.

- B. Hetero-Bhautic 'quasi-compounds'.—The Nyāya-Vaisesika maintains that in the case of bi-Bhautic (or poly-Bhautic) compounds, which are only quasi-compounds, there is another kind of contact between the heterogeneous atoms of the different Bhutas, which may be called dynamic contact and is distinguished in its operations as Upashtambha, Vishtambha or Avashṭambha (उपष्टम्भ, विष्टम्भ or अवष्टम्भ). In some cases, it so happens that the atoms of different isomeric modes of the same Bhūta do not chemically combine under the mere application of heat ;—they require to be surrounded (and 'excited', 'energised') by atoms of different Bhutas. For example, in the case of the oils and fats as well as of plant saps and fruit juices the Earth-atoms must be dissolved in water (Ap), and it is only when the water atoms (Ap-atoms) congregate round the former that dynamic intra-atomic

forces are set up, and the Earth-atoms (with the water atoms in dynamic contact) now take on peculiar infra-sensible characters (colours, tastes, smells) under the impact of the heat corpuscles, and then, under further impact, fall into groupings or collocations (of a very peculiar nature, to be presently explained) which determine the nature of the composite substance thus produced. Here it is the water-atoms that are dynamic (उपष्टम्भक), and excite the Earth-atoms, and these substances, oils and fats (तेलवर्गं and दृश्यवर्गं), as well as acids (अम्लवर्गं) are, because of the Earth radicles regarded as Earth-compounds (or Earth-substances). (पाण्डितावधारिष्ठादिनिः परमाकृभिः प्रयुक्तादिक्रमेच दृश्यादिद्रव्यमारब्धते । तत्र च उपष्टम्भकतया निमित्तामापद्धाः पानीयाद्यवर्याः । तेषां संयुक्तसमवायेन खेहस्त्रोपवर्यते । तेजस्त्रीरादिषु पार्थिवलसिद्धिः । नेत्रस्त्र भौमानसिन्धनमात् दृश्यत् । Udayana). In the above instances, Ap (water) acts as dynamic (Upash-tambhaka, (उपष्टम्भक), but Tejas

and Váyu can also act in the same way on Earth-particles. Conversely, Earth-particles may act dynamically on the atoms of the other Bhútas. For example, in the case of mercury and the metals which are conceived in the Nyáya-Vaiseshika to be igneous bodies (in fact they are supposed to be formed under the subterranean heat आकरण), the Tejas corpuscles are believed to form the radicles, and the Earth-particles are dynamic (उपष्टथक). (सुवर्णादि निरन्तरं भायमानमपि न पूर्वेष्यं जाहाति । तेजेष्व द्रव्यात्मरेष्व प्रतिवृत्ततात् उपष्टथकीइपि पार्थिव-भागः सहस्रप एवानुवर्तते, यतु पुटपाकादिना रक्षसारता हस्ते तनिश्चीमूलाभिभावकतत्तद्रव्योपगमात् । परेत्वा पारदादि व्याख्यातम् । Udayana, Kiranávali, तेजोनिरुपचरम् । Cf. also योइपि तेजसमिक्षति सुवर्णं तेजाव्यव पार्थिवी भाग उपष्टथक एष्टव्यः ।)

It may be here noted that Gangesa, the author of the Tattvachintámani, conjectures that even gold can be evaporated or made to disappear by the application of intense heat;

यत् तु द्विवरपदैः क्षयः प्रवीणः प्रवायन-
संवीक्षण तु चर्याभास वद्वया नक्षत्रः । But
Mathuránátha notes here—प्रवायनाक्षायो-
चेदउमडे । (अविचर्यादरहम) .

But while every Bhúta can act dynamically as उपराज 'energiser', 'exciter', it is the Earth-Bhúta alone which is capable of exercising the power of arrest or inhibition of molecular motion or the motion of particles due to gravity as in fluids (Vishtambha, विष्टम्ब), or the power of counteracting the tendency in a given set of atoms to fall into a peculiar order or group (वृहिरीषिलम्), (न च परिवृत्तं चक्री इवायरं वृहिट्याक्षि-
त्युभ्युः च विद्यति । Udayana, Kiranávali, वृहिरीषिलवलम् । विट्यकलं खाता-
विक्षुद्यापवद्याक्षरविशिलिक्ष्यकलम् । वृहिरीषिल-
च खाताविक्षुद्यापवद्याक्षरविशिलिक्ष्यकलम् । Vardha-
mána, Kiranávalíprakása, *ibid.*)

Oils, fats, milks—Bi-bhaatic quasi-compounds, with Ap as energiser :—Oleaginous substances.

(वाचस्पति च इति) are divided by Udayana into (1) oils, derived from vegetables, (2) butters derived from milk, and (3) fats derived from animals. The medical schools, as we have seen, recognise animal oils as distinguished from vegetable oils. Vegetable fats (e. g. निष्ठुरा) are also mentioned. Váchaspati in the Tátparyyatíká contends that mustard oil has not the flavour and smell characteristic of the true oils (sesamum, linseed etc.), and is classed with the latter by convention. Judged by the flavour test, A'mikshá (the casein substance formed by mixing milk-curd with hot boiled milk) is to be classed with milk substances. So also Takra, whey,— but Vájina, the thin fluid that is left after the A'mikshá (casein substance) is separated, cannot be classed as milk. It may be added that the milks and curds as well as oils and fats derived from different species of vegetables or animals are supposed to differ in their ultimate structural arrangement and therefore in kind ; but Vallabha thinks that the ghées (clarified butters) prepared from different kinds of milk are of the same kind ; in other words, the milks and curds are 'polymeric', the ghées (clarified butters), 'isomeric', using these terms, as before, in a loose general sense.....
 वैचारिकाः प्रत्य स्त्रियोऽप्यनुभवात् गोवर्धन-
 वाचस्पतिः प्रत्य स्त्रियोऽप्यनुभवात् गोवर्धन-

सार्वप्रादपि तु छत्यपदिश्च । Udayana, Kiranávalí,
पृष्ठिगोगिकपचम् । Vallabha notes that ghees do
not differ in kind, as milks (and curds) do :—
अती माहिषगव्यादिदुग्धेषु दर्शकवत् छतादिषु जातिमेद-
पवासानिति चेत् ।—Vallabha, Lislávati. Compare
Váchaspati, II, 2, 65 :—चाप्यतेलादीर्णा जातिस्तु गन्धे वा
रसेन वा अव्यते । अतएव न सार्वपादीर्णा तेलत्वमिति । तदशक्तयी-
र्गम्यरसयीरभावात् । भास्तु सेलशब्दयोगः । चौरजातिरपि रसम्बोध ।
अतएवामिच्छायाः चौरलम् । न तु वाजिनस्य तदशक्तया रसमेदत्त
वाजिने चभावात् चामिच्छायां च भावात् ।

III. Mixtures like soups, solutions etc :—A soup is a physical mixture of a peculiar kind, from which evaporation ordinarily sets the water free (cf. Udayana's चन्द्रीतसुक्ति infra). When meat is boiled in water, there is the application of heat, with chemical changes in the meat, but the combination of meat-particles and water-particles in the soup is only physical combination, and not a chemical one. It is of course not a true compound, neither is it a quasi-compound, like milk (in which the water-particles are 'energisers' of the Earth-particles). Milk, for example, retains its milky substance, when it coagulates or becomes solid, (this of course is also the case with mono-Bhautic substances whether elementary or compound, e. g. water, which becomes ice,) but the substance we call a soup or solution ceases to be a soup

or solution, the moment it solidifies. Uddyotakara notices gruel, baths, and lyes (alkaline solutions) as mixtures of this class (एतेन पापकाच्छिकविवेकावचारादयः प्रत्यक्षाः । Várttika, Chap. I, A'hnika 1, Sútra 14). यूको हि नाम उतपन्नपाकजागां द्रव्याणां कालविशेषानुयुक्ते सति द्रव्यान्तरसंयुक्तानां पाकजीत्यसौ यः संयोगः स दृष्ट इति । एतेन पापकाच्छिकविवेकावचारादयः प्रत्यक्षाः । Uddyotakara, Várttika, Chap. I, A'hnika 1, Sútra 14. *Vide also* Váchaspati's comment : उतपन्नपाकजागां तैले सर्पिषि वा पिण्डमास-पिण्डावश्वानां द्रव्यान्तरेण तीयेन संयुक्तानां पाकजीत्पत्तौ सत्यां जासौ सहसा इत्युक्तं कालविशेषानुयुक्ते सततैति । स च संयोगभेद-एव तोयमासयीर्नतु अवयवो विजातीययीरमारम्भकलात् । नापि यूषजातीय तीयसंयोगि द्रव्यं चौरजातीयमिवेति युक्तम् । तीयविरहे काठिङ्गेऽपि चौरबुद्धिव्यपदेश्यीक्षाद्वस्थात् । इह तु काठिङ्गे न यूषकुद्धिव्यपदेश्यौ इति सम्बन्धित एव तोयमासयोर्दृष्ट इति न्यायम् । स च अनुभवसिद्धः संयोगिव्यतिरिक्तः । Váchaspati, Tátparyyatíká, *ibid.* For salt and alkaline solutions, *vide* Kiranávalí—यत् पुगरम्भुधिसिद्धुभेदेन क्षारादिरपि रसः पापसे उपलब्धते स दशमूलकवायस्येव पार्थिवद्रव्योपाच्छिकः । कथमन्यथा तस्यैव घनपीतमुक्तस्य रसो मधुर एव । Udayana, Kiranávalí, जलनिष्ठपत्तम् ।

Chemical action and Heat :—The operation of heat is of course universally implied in chemical

combinations. Where the application of external heat is wanting, Vátyáyana, the great Doctor of the Nyáya, points to the operation of internal heat. (e.g. इकीषादुः चूपातुगा चंद्रैषः चायरेष तेजः पच्यामः रुद्रम् निर्वर्तति ।—Vátyáyana-Bháshya, Chap. IV, A'hnika 1, Sútra 47). In the case of combustion, we have seen Vijnána-bhikshu explain the heat as latent in the Earth-substance, the fuel, from which it breaks forth. Udayana points out that the solar heat is the source of all the stores of heat required for chemical change in the world. The change of colours in grasses, for example, is due to Tejas, in the form of latent (invisible) heat, not in the form of Agni; and the cold in winter cannot take away this store derived from the Sun. (द्वादिविकारो हि बहि चाहिपराङ्गिनाप्तिः च नूनोच्चापेषेच तेजः पर्याप्तः । वाहये च पादे चनिनिति इवनिति । न विविहनिट्वापयते । न हि दौरक तेजः मैत्रोक्तवाक्त्वेऽर्द्धिनाशयमः चलते । चतु विकारो चाहिद्वयो विविहः सीमित्वा एव इवहेतु द्वादिषु त्रिविकारो विरोधो वा । एव चाहिपराङ्गिनापेषेच चहिः दात्रये चलतान् । एव द्वंनकर्मनात्त्वा योग्यामुदक्षयापित्वाद् विहेतुरक्तवान् चनित्वात् । Udayana, Kirasávalí चाहिपराङ्गिनिविकारम् ।) Similarly, it is under this heat that the unripe mango ripens, i.e.

colour, taste, smell etc., showing that there is chemical transformation, or subtle decomposition and recombination going on; and this is also the case with the rusting of the metals, which is a combustion due to the solar heat (सूर्यगत) even as the conversion of food into chyle and of chyle into blood are instances of chemical action due to the internal animal heat (अठरानय or औद्योगिक). But the kind of contact with heat-corpuscles, in other words, the kind of chemical action (प्रभाव) which transforms colours is supposed to differ from that which transforms flavour (विषवरीक्षणसंबोध) and पात्र) and this last from that which produces a change of smell, or tactile quality. (पात्रो जाति विज्ञातीवतेःसंबोधः । च च जाताजातीवतः । उपजनकी विज्ञातीवतेःसंबोधकहयेत्वा रसजनको विज्ञातीवतः । एवं अद्वादी चति तता । एवंप्रकारेण लिङ्गलिङ्गविज्ञातीवतः पात्रः कार्यवैष्टुक्त्वेन वज्रनीयः । ततादि दृष्टुशानिश्चापादी उच्चरात्रविज्ञातीवतेःसंबोधात् पूर्वहरिवद्यनाशक्त्वात् पीतादेवतप्रिः पूर्वरक्तम् वज्रज्वेषामुभवात् । अपित् पूर्वहरिवद्यनाशेऽपि रक्तपराहित्वाते विज्ञातीवतेःसंबोधवद्यनाशक्त्वात् पूर्वतयाकरहत्वादै नहुररक्तामुभवात् । वज्राद्युपजनकापेक्षा रसजनकी विज्ञात्वा एवं वज्रजनकी विज्ञात्वा रसज्जीवात्मः उपरक्तीरपराहिती चति पूर्ववज्रनादै विज्ञातीवताक्षयात् दुर्लिङ्गविषयतः । एवं अर्जुनजनकीप्रिः पात्रवज्रात् वज्रिन्

अर्थात् चदुष्यत्वानुभवात् । अतएव पार्थिवपरमाणुमेकजातीयत्वे ६ पि-
याकमस्त्रिया विजातीयद्रव्यात्मकरानुभवः । यथा गोभुक्तव्यादीना चप्र-
मास्त्रं भक्ते ट्वारकपरमाणुषु विजातीयतेजः संयोगवशात् पूर्व-
रूपादित्वानुष्ट्रियात् तदन्तरं दुर्धे याहां रूपादिकं वर्तते
ताहश्चरपरमधर्मश्चनकाशेजः संयोग जायन्ते । तदुत्तरं ताहश्चरपादय-
उत्तपद्यन्ते । ताहश्चरपादिविशिष्टपरमाणुभिर्द्वयाण्यमारभते । ततः
व्याख्यादित्रिमेष महादुष्यारथ इति । Nyáyabodhiní on
Annam Bhatta's Tarkasangraha). Heat and light
rays are supposed to consist of indefinitely small
particles which dart forth or radiate in all directions
rectilineally with a sort of conical dispersion and
with inconceivable velocity. They may either (1)
penetrate through inter-atomic (or inter-molecular)
spaces as in cases of conduction of heat which when
applied under the pot boils the water, or fries the
paddy where there is no chemical action in the pot,
no decomposition and recombination of its atoms, no
change in the molecular collocation ; or, as with light
rays in cases of translucency or transparency
(अप्तता) penetrate through the inter-atomic spaces
with Parispanda of the nature of deflection or
refraction (तिर्यग्मन, Udyotakara), in the same
way as when fluids penetrate through porous bodies
(तच परिष्पन्दः तिर्यग्मनं परिष्पन्दः पात इति—Udyo-

takara, commenting on Vátsyáyaná's परिक्षेप-परिक्षेपी, Sútra 47, Añnika 1, Chap. III.) or (2) impinge on the atoms, and rebound back—which explains reflection (मूर्खन्, किरणविष्टन्—Varáhamihira, रज्जुपरावर्तन्—Vátsyáyaná) or otherwise be obstructed by the atoms in their path, which would explain degrees of opacity, the casting of shadows, etc., all these operations being also physical, and unattended with decomposition and recombination or alteration of molecular grouping, or (3) lastly, strike the atoms in a peculiar way, so as to break up their grouping, transform the physico-chemical characters of the atoms, and again recombine them, all by means of continual impact with inconceivable velocity, an operation which explains all cases of chemical combination. (अचिक्षो हि तेजसो खाघवातिशयै वेगातिशयः यत् प्राचीना चलचूषावलम्बिनि एव भगवति मयूखमालिनि भवनोदरेषु आलोक-इत्यभिमानो लौकिकानाम्। (Udyana, Kiranávalí, तेजोनिष्ठपद्म—taken from Váchaspati, Tátparyyatáská, प्रत्यय-खण्डनम्।) Cf. also (चाहुं तेजः वेगवता सावित्रेण तेजसा न प्रतिष्ठते। Váchaspati—बर्द्धेष्वि पिञ्जितमपि तेजः प्रसर्यत् प्रासादोदरं व्याप्तोति। तत् कल्य हेतोः पृथ्यवात्। स्वावसः प्रसरद्यि न स्वपरिमाचातुरिषायिनः प्रत्ययमावसे किं सु विद्यमेदातुरिषायिनम्। *ibid.* Cf. कठिकावल्लरितीपञ्चविरपि

द दाहकाद्यवाद्या चटिकारीनो वेतोवरतेरा लिप्तवाद्यवाद्या प्रदोषवादाद्य-
दीयोपद्धति । Udayana, तैत्रीनिष्ठमध्य, in reply to the
objection—इहि हि प्राप्य गृहीतात् प्रविवादिना चटिकाद्यवेष
लिप्तवाद्याद्यं प्रवर्णन्तवादित्वं नादीत वाकाद्यापात्रादित्वं कठी न
तैत्तिरङ् । (Udayana, *ibid.*) Definition of लक्ष्यवा—
द्रव्याद्यारुपाद्याद्यस्यस्यवादः लक्ष्यता । उद्योगविवादः वाकाद्य-
पटवाद्याटिकार्यर्थविवेषः । लाभाद्यित्वं च पापवाद
वेत्तानीप्रविवादाद् । Uddyotakara, Chap. III, A'hnika
1, Sútra 38. वादिवरतःः चटिकाद्यविवेषित्वं दाष्ठेऽपि-
कावाद् । Sútra 47, where Uddyotakara notes—कोऽप-
मविवादः—वस्त्र द्रव्याद्यवाद्या न वृद्धये वस्त्र द्रव्याद्यवादः
चवृद्धयानक दीड़निष्ठमध्यः लोहविवाद इति । Váchaspati
explains वस्त्र द्रव्याद्यवाद्यवादित्वादिः वस्त्रवाद्यवाद्यवादित्वादिः वृद्धम्
वस्त्र लिप्तये वस्त्र द्रव्याद्यवाद्यवादित्वादिरप्युद्धयानक
चवरापद्धतेऽपि विवेष्यते । Cf. Váteyá-
yana on Sútra 47, A'hnika 1, Chap. III. On the
other hand in chemical combination, असःप्रवेषः
ज्ञानानीरतुमीयते । तेष्व वेत्ताद्यवेष विश्वामीत्वं चित्त-
वादात् च च वयेत् लिप्ता, लिप्ताती लिप्तात्, लिप्तात् च
चारणकांदीविवादः etc.—Jayanta, Mahájári, शूद्रवैकल्य-
पूर्ववद्य । For opacity, shadows, etc., *vide* लाक तु
तैत्तिरप्यवादीरावरकाग् गूर्जितात् परमाकृता तैत्तिरप्यवादी-
राविवेदि । वस्त्र च च चावर्त्य वस्त्र वादेवि । विरु-
द्धेवाद्यवेषित्वं द्रव्यवृद्धयादित्वं वाका अवलिप्तेवदि । उपर्यु

वाचस्पतिः उद्योगीः तु तानि वर्णः उद्योगानि । Uddyotakara, Chap. IV. A'hnika 2, Sútra 25. For reflection, and its laws, I quote passages in my paper on Hindu Physics and Mechanics, to which the student of the history of Optics is referred.

Arrangement of atoms in Space :—The Nyáya conveys atomic magnitudes as Párimándalas, a term which indicates a spherical shape. (निया॒परि॒मांडल—परिमांडलमेव पारिमांडलम्—Sankaramisra). To conceive position in space, Váchaspati takes three axes, one proceeding from the point of sunrise in the horizon to that of sunset on any particular day, (roughly speaking, from the East to the West) ;—a second bisecting this line at right angles on the horizontal plane, (roughly speaking, from the North to the South), and the third proceeding from the point of their section up to the meridian position of the sun on that day, (roughly speaking, up and down). The position of any point in Space, relatively to another point, may now be given by measuring distances along these three directions, i.e. by arranging in a numerical series the intervening points of contact, the less magnitude or distance being that which comes earlier in this series, and the greater that which comes later. The position of any single atom in Space with reference to another may be indicated in this

way with reference to the three axes. But this gives only a geometrical analysis of the conception of three-dimensioned Space, though it must be admitted in all fairness that by dint of clear thinking it anticipates in a rudimentary manner not only the foundations of solid (co-ordinate) geometry, but also of the geometry of position, and especially the conception of Space as a Manifold, which alone can serve as the basis of a generalisation comprehending all different possible kinds of geometry, Euclidean and non-Euclidean.

(एकत्रेऽपि दिवः चादित्योदयदेशप्रव्यासमन्तरेष्टं युजो
यः स इतराणादविप्रलग्नादप्रदेशसंयोगात् परमाणुः पूर्वः एवमादि-
त्याकामयदेशप्रव्यासमन्तरेष्टं युजो यः स इतराणादविप्रलग्नादेश-
संयोगात् परमाणुः परमाणुः तौ च पूर्वप्रिमा परमाणु-
चयेत्य यः स्थैर्योदयाकामयदेशप्रवल्ग्नादेशसंयोगः स मध्य-
वर्तीः। एवमेतयोर्यो तिर्थं ग्रदेशसम्बन्धी मध्यस्थ चार्जं वेन
अवस्थितौ पान्त्रवर्ती तौ दक्षिणवर्ती परमाणुः। एवं
मध्यनिदर्शितस्थैर्यसम्प्रिकर्त्तिप्रकर्त्ती चयेत्य उपर्युक्तभावो
इष्टव्यः। संयुक्तसंयोगात्यत्यनुभवते च सम्प्रिकर्त्तिप्रकर्त्ती पूर्व-
संस्थाविहीनता च चक्रता परसंस्थाविहीनता च मृशकृम्।

Váchaspati, Tátparyyatíká, Chap. IV. A'hnika 2,
Sútra 25.

The original physical arrangement of atoms is also given. Each atom is in contact with six other atoms, which gives a cubical arrangement, एवं

दिव्वोऽपि एकसा चपि संयोग एव भागाः सोऽयं परमाणुः:
 षट्केन युगपदयोगी मूर्त्त्वमावपयुक्तः न सावयवत्प्रयुक्तः। *ibid.*
 Cf. also the objection in the Buddhist Kārikā.
 षट्केन युगपदयोगे परमाणुः चक्षता। चक्षा समानदेशत्वे
 पित्तः स्वादशुभावकः॥ This is the typical primordial
 arrangement, and variations in the collocation
 of atoms and molecules (अङ्ग, अवयवसम्बन्धेण). as
 we have seen, were conceived to account for
 the variety of isomeric modes of the same Bhūta,
 as well as of mono-Bhautic and poly-Bhautic
 compounds.

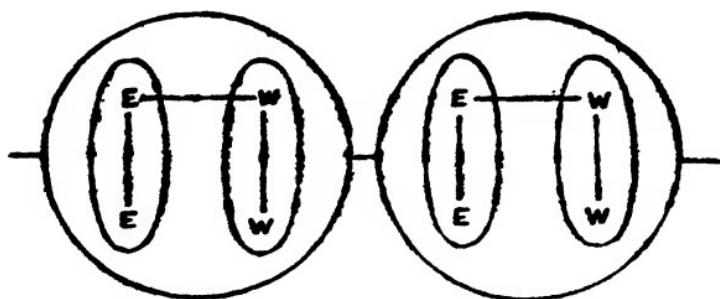
The molecular arrangement in the case of bi-Bhautic compounds is very peculiar. Two substances, say Earth and Ap (water), form a quasi-compound, first, and each substance breaks up into atoms, one atom of Earth comes into contact with one of Ap. But the two do not form a binary molecule. Instead, this contact of heterogeneous atoms leads to a curions result. The atom of Earth combines with a neighbouring atom of its own class, and forms a binary molecule. Simultaneously the atom of Ap combines with another Ap-atom, and forms a binary molecule. Now the first binary molecule links on to the atom of Ap, and similarly the second binary molecule links on to the atom of Earth. The moment after, the two binary molecules take on the physico-

chemical characters of Earth and Ap respectively, and simultaneously with the assumption of these physico-chemical characters, the binary molecules enter into complex contact (संकीर्ण संवेष). In all this process, work is done only in the first instant, in the contact of an atom of Earth with one of Ap—the resulting contacts, of atom with binary molecule and of the binary molecules with each other, involve no further expenditure of Energy. Thus we get a particle holding two binary molecules (of Earth and Ap respectively) in complex contact, and such particles continue to be formed. In this way the particles of the two substances arrange themselves, and the peculiarity of this molecular arrangement explains the resulting mixed or compound qualities of this class of quasi-compounds. (संकीर्णसंवेषः) अप्यात्मानम्

पिरोक्कारा का नियमित वारचर्टोविकारणः वारचर्ट-
वारचर्टीवूर्णेषः वार्चार्चार्जः संवीकः ।.....इस-
आठ चर्चीदर्शनः वार्च । वहा वार्चिकार्चीरक्षीः संवीक
उति चर्चेन पार्चिति पार्चिका चर्चेन चार्चेन च
चार्चेन तुवयस्त्रीकी अवशक्ता वार्चा संवीकार्चा पार्चि-
वार्चे चार्चुके तुवयस्त्रार्चेन । वार्ची वर्चित् वार्ची असुक्तीः
वारचर्टवूर्णेष्मिति चर्चायुक्तिः वर्चिदेव वार्ची इवरीत-
वारचर्टवारचर्टाद् संवीकार् इवरीतवार्चार्जवी संवीकी तुवय-
द्वृत्तेवै । चिं वार्च । वारचर्टीमिता च चार्चेन चार्चे
चर्चां चंत्रात्तेवै चर्ची वार्च । चर्चः पार्चिति चार्चुक वारचर्टीमिता

चावेन चकुता उवाचते । चावेनि शास्त्रं चारचत्यीविदा चार्दिवेति
(Praastapáda-Bháshya, गुणने संधीविद्यपद् ।)

The whole process may be graphically represented as follows :—



E = an atom of Earth.

W = an atom of water (Ap).

E

— a binary molecule
of Earth.

W

— a binary molecule
of water (Ap).

Molecules of a bi-
Bhaute quasi-com-
pound ;—graphic
formula of complex
contact.

I will conclude this account of ancient (and mediæval) Hindu chemistry with a note on the conception of molecular (atomic) motion, Parispanda, and the different varieties of such motion which were conceived to account for the physical phenomena of sound, light and heat. Any attempt to differentiate rigidly between Mechanics and

Physics on the one hand and Chemistry on the other at this primitive stage would be an idle affectation. My paper on Hindu Mechanics and Physics will give a detailed exposition in a separate treatise.

Parispanda :—Resolution of all physical action into motion :—

Parispanda sometimes stands for motion molar as well as molecular, but more often for the subtle motion of atoms or molecules. The radical meaning of the term is whirling or rotary motion, a circling motion, but it may also include simple harmonic motion (*e. g.* vibration). All action, operation, work (क्रिया व्यापार) is ultimately traced to this form of subtle motion lodged in the atoms or in the matter-stuff. The Vedānta, for example, speaks of a cosmic vibratory motion (सर्वत्रोक्तपरिस्पन्दनम्—Saṅkara).—Akāsa, in the Vedānta, as we have seen, is the first stadium in the evolution of Matter, which gives off Váyu, which gives off Tejas, and so on; but Akāsa (Ether) itself passes through two stages before the emanation of the Súkshmabhúta Váyu :—(1) the motionless ubiquitous primordial matter-stuff (answering to the Sánkhya Bhútádi) called Puránam kham (पुराणं खं) and (2) a subtle integration, the pure unquintuplicated Súkshmabhúta called Váyuram Kham

(वायुरं सं) (answering to the Sánkhyá Tanmátra stage). It is this subtle Akása, in its Tanmátric integration, i. e. in the derivative form, which is subject to an incessant Parispanda. The gaseous stage of matter (the Vedántic Váyu) is indeed matter in a state of Parispandic motion (वायोः परिष्पन्दाव्यवकलात्—Sankara): So also the bio-motor and sensori-motor principles apart from the directive Intelligence of the Self (प्राचल परिष्पन्दाव्यवकलादेव—यदैतम् स्थूलं सञ्चय तत्सर्वं मनःस्मितमात्रम्—Sankara). The Sánkhyá also conceives this Parispanda to characterise every process and phenomenon of cosmic evolution (अकं सक्रियं परिष्पन्दत्—Váchaspati, Kaumudí). Bhutas, organisms, mental organs, as modes of Prakriti (considered apart from the Intelligence of Purusha) are all subject to this Parispanda बुद्धादयो देह लब्जस्ते देहान्तरं उपाददते इति तेषां परिष्पन्दः । एतोपर्याव्यादोनां च परिष्पन्दः प्रसिद्ध एव ।—Váchaspati on Káriká 10). On the other hand, Prakrti as the Avyakta, the a-cosmic, the un-manifest ground, with resolution only of like to like (सहश्चपरिष्पन्द), is devoid of all Parispandic motion (यथापि चव्यकालार्थं परिष्पामस्तच्चया किंया, तथापि परिष्पन्दो नार्थ । ibid. on Káriká 10). The Nyáya-Vaiseshika finds Parispanda in all

forms of matter, except A'kása which, in that system, is non-atomic and incapable of any change or activity (निकृत्य). But all atoms from those of Váyu downwards, are in incessant motion. The world at bottom is an infinitude of continually whirling (or vibratory) particles (अनवरतपरिशप्द-मागापरिमितपवनादिपरमाणवः—Raghunátha ;—compare also Udayana-Kusumáñjali, Stavaka V.—परमाणवः हि गतिशीलत्वात् पतञ्जयपदेशः पतनीति ।). All physical action consists in motion. The Nyáya-Vaiseshika rejects force, power, operation (शक्ति) except as modes of motion. Jayanta indeed states : we do not acknowledge any mysterious power or operation, which the senses do not and cannot report to us. But this denial of Force (शक्ति) and of unperceived and unperceivable operation (असौन्द्रियव्यापार) is put forward as a philosophical (epistemological and metaphysical) proposition to justify the Nyáya analysis of the causal *nexus* into mere invariable and unconditional antecedence among phenomena without productive power or efficiency अव्याप्तिसिद्धिशब्द नियतपूर्ववर्त्तिः—Bháshá-Parichchheda). It is not of course intended to question the existence of Parispanda, which is of the nature of motion, and which, though subtle and therefore infra-sensible (सूक्ष्म and अनुदृतश्च, not असौन्द्रिय), is the ultimate form of all physical

activity. (परिस्थित एव भौतिको व्यापारः करीवद्यः । अती-
न्द्रियसु व्यापारः नास्तीति ब्रूमहे ।.....तथात् कारक-
चक्रेण चलता अन्ते फलम् । व प्रवस्थनादन्वी व्यापार-
उपलंभते । Jayanta, Nyáya-Mañjarí, Añnika I). The effect (no less than the action) is, in all cases of material causation, the resultant of the combined motions of the various (material and efficient) causes involved (e. g. in the case of पाक-समुदित-देवदत्तादिसकलकारकनिकरपरिस्थित एव विशिष्टफलाद्यचक्रः पाक इत्युच्यते । ... अथ व्यापार एवेषः सर्वः संभूय साध्यतं । किं फलेनापराह्ण वः तज्जि संभूय साध्ययाम ।—Jayanta, Nyáya-mañjarí, Añnika I).

But, in the Nyáya-Vaisesika, though all action of matter on matter is thus resolved into motion, conscious activity is sharply distinguished from all forms of motion, as against the Sánkhya-Vedánta, which, as we have seen, considered every thing other than Intelligence, the Purusha or the transcendental Self, to arise in the course of cosmic Evolution, and therefore to be subject to Parispandic motion. (क्रियाविशेष इवायं व्यापारो शातुरान्नरः । स्पन्दाभावकविहृतक्रियालक्षणविलक्षणः ।—Quoted in Jayanta's Nyáya-mañjarí, Añnika IV).

Santána, i. e. Gati-santána (including wave motion and current motion or convection) : Kampa santána, Spandana, (vibration) :—Charaka notes

three kinds of *santānas*, serial motions, *miz.*, those of water, sound and light (अखसतान्, अष्टसतान् and अचित्तसतान्). Chakrapāni points out that a wave of sound travels more rapidly than a wave of water, and much less rapidly than a ray of light. In Hindu Mechanics, a current of water (downward flow, सद्धन) is conceived to consist of particles moving in an uninterrupted series under the action of gravity and fluidity (गुह्य and द्रव्य). A ray of light implies the rectilinear propagation of indefinitely minute corpuscles, in all directions, with inconceivable velocity, and a sort of conical dispersion (अचित्तो हि वेगातिशयः तेजःप्रसर्पन् व्याप्तोति पृथग्यतात् Uddyotakara—Vāchaspati). A wave of water (वीचितरङ्ग) implies the transmission of vibratory motion in the water particles. (Cf. Jayanta—पतदधनपयोविन्दु-संदाहरणम्बन्धमात्, A'hnika II). A wave of sound is conceived by some on the analogy of a wave of water (वीचितरङ्गन्याय), only the air-waves (cf. the Mīmāṃsā) or the sound-waves in and through the vehicle of air waves (cf. the Nyāya-Vaiseshika) travel by concentric circles not in one but in all planes. (N. B. this assumes transverse waves). Others hold that the air waves (cf. the Vākyapadiya) or the sound and air waves (cf. Uddyotakara) are propagated by the transmission of the vibration in all directions, leading to conjunction and disjunction of air-particles, so that the wave may be said to expand by alternate concentric

spherical layers of rarefaction and condensation (प्रचय) (N. B. this assumes longitudinal waves),—
 (ब्रह्मगीतकाचाय—cf. संयोगविभागा नैरन्देश क्रियमाणः ब्रह्मभिव्यञ्जनो नादशब्दवाचाः (*Savara-Bháshya* 1—1—17) अभिधातेन हि प्रेरिता वायवः स्थिरितानि वायुक्तराचि प्रति वायमाणाः सर्वतोदिकान् संयोगविभागान् उत्पादयन्ति—*ibid.* 1—1—13). The Vákyapadíya describes articulate sounds (*Varnas*) and indeed all sounds (*sabdas*) as only forms of air set in motion, with rarefaction and condensation (प्रचय), and capable of variations of velocity and configuration (स्थानेष्वभिहृष्टो वायुः ब्रह्मत्वं प्रतिपद्यते। तस्य वारणसामर्थ्यात् वेगप्रचयधर्मिणः। संनिपातात् विभव्यन्ते सारवत्तोऽपि मूर्तयः—*Vákyapadíya*, Kánda I. Sloka 109) (*vide* my paper on Hindu Mechanics and Physics). (For the Hindu doctrine of scientific Method, *vide* Appendix; for certain interesting recipes of chemical technology, *vide* Addenda).

I had intended to conclude this survey of Hindu Physico-chemical science with a comparative estimate of the evolution of scientific ideas in the culture-history (*kultur-geschichte*) of the Chinese, the Greeks and the Arabs, as an Essay in the historico-comparative method of investigation (*vide* the Introduction to my Comparative studies in Vaishnavism and Christianity for a correction of this method), but space forbids, and the reader too, I fancy.

The Date of Kasaratnasamuchchaya.

While the present volume was about to issue from the press, Mr. T. G. Kála, Editor of the Marhattá Journal "Samálochaka", sent us a critical notice of R. R. S. As there are some important historical facts brought to light and as the date of this work arrived at from quite independent sources tallies with that assigned by us (Vol. I. Intro. LXXXIX), we make no apology for reproducing its substance in a condensed form.

Charpati or Charpatinátha of the Nátha school is mentioned in the 'R. R. S., (see VI, 58, Poona edition), as also king Singhana.

The Navanátha Saktisára, a Marhattá work by Narahari Mála, gives some legendary information about this Charpatinátha and speaks of him as a contemporary of Matsyendranátha. On the left has

मत्स्येन्द्रनाथ	}	been given the genealogy of the pupils of मत्स्येन्द्रनाथ. The last, शानदेव or शानेश्वर, was the celebrated Marhattá Saint and author of a commentary on the भगवद्गीता called शानेश्वरी.* It was written in Saka 1212,
गोरखनाथ		
गेमीनाथ		
निहत्तिनाथ		
शानदेव		

i.e., A. D. 1290. So मत्स्येन्द्र and Charpatinátha must have lived at the beginning of the thirteenth century A. D.

*See the concluding portion of शानेश्वरी, a Marhattá work.

The R. R. S. which mentions the Siddha Charpati must be therefore later than the first half of the thirteenth century A. D.

सिद्धचर्पति II (A.D. 1069)

सिंघण I

सिंघण

सिंघण (A. D. 1191)

कैमपाल (A. D. 1191-210)

सिंघण II (A.D. 1210-1247)

Among the Yādava

kings of Devagiri or Dau-latābād, there were two kings by the name of Singhana. Taking the Singhana mentioned by R. R. S. to be the second, we are required to place the composition of the

work in the latter half of the 13th century. On the whole the R. R. S. may be safely taken to be a work written *about 1300 A. D.*

THE WEIGHT OF AIR.

(*By Principal B. N. Seal*).

Experiments were of course conducted for purposes of chemical operations in relation to the arts and manufactures, e.g., metallurgy, dyeing, pharmacy, perfumery, cosmetics, horticulture, and themaking of glass (lenses and mirrors of various kinds are mentioned, the spherical, oval—गोल and वर्षुल, being well-known—Pliny indeed mentions that the best glass ever made was Indian glass). But of Experiment as an independent method of proof or discovery, the instances are rare. I may

note one interesting example in Udayana's *Kiranávali*, relating to the weight of air. Udayana argues that air must be a distinct and independent Bhúta, for if air were made of the Earth-Bhúta, it would have weight, and it has none. To prove the absence of weight, he refers to an experiment. A small bladder made of a thin membrane, filled with air, will not cause a greater descent in the scale than the same bladder weighed empty. Hence the air possesses no weight. Then Udayana makes an interesting statement. It may be objected, he says by one who accepts the weight of air—that this argument is inconclusive. For a counter-experiment may be suggested. The balloon filled with smoke (or gas, धूम) rises in the air, whereas the air-filled balloon comes down. This would go to show that air has weight. Udayana replies that this would only show that both smoke (gas, धूम) and air have no weight. The Hindus appear to have been ignorant of the principle of Archimedes, at least as applied to gases. Vallabháchárya in the *Lilávatí* speaks of a peculiar resistance to sinking (or gravity) exercised by water, which explains the tendency in certain objects to float or to come up to the surface of the water but the description shows that he had no clear ideas on the subject. Cf. Udayana, *Kiranávali*, शास्त्रशिष्टपत्रम् ! Cf. also Vallabhácháryya, *Lilávatí*.

APPENDIX.

On the Scientific Method of the Hindus.

(BY PRINCIPAL BRAJENDRANATH SEAL.)

The Doctrine of Scientific Method :—A study of the Hindu Methodology of Science is absolutely essential to a right understanding of Hindu positive Science, its strength and its weakness, its range and its limitations. Apart from this rigorous Scientific Method, Hindu Chemistry, such as it is, would be all practical recipe, or all unverified speculation. This, however, would be a very inadequate and indeed erroneous view of this early achievement of the human mind. That the whole movement was genuinely and *positively* scientific, though arrested at an early stage, will appear from the following brief synopsis of the Hindu Methodology of Science.

Criterion or Test of Truth (after the Buddhists) :—The ultimate Criterion of Truth is found not in mere cognitive presentation, but in the correspondence between the cognitive and the practical activity of the self, which together are supposed to form the circuit of consciousness. That knowledge is valid which prompts an activity ending in fruition. Cf. the distinction between सत्यादिशास्त्र and विकल्पादिशास्त्र। Also compare, प्रमाणतोऽर्थतिपचौ प्रश्निशासनात् चर्चयत् प्रमाणम्—

Vátsyáyana). Truth, the Buddhists contend, is *not* self-evidence, *not* the agreement between ideas, *nor* the agreement of the idea with the reality beyond if any, for this cannot be attained direct, but the harmony of experience (सम्बाद), which is implied when the volitional reaction, that is prompted by a cognition and that completes the circuit of consciousness, meets with fruition, *i. e.*, realises its immediate end (cf. Sríharsha, Khandana Khanda Khádyá on the relation of प्रभा to जीकव्यवहार). This is the material aspect of Truth. The formal aspect is given in a principle which governs all presentations in consciousness, and which combines the three moments of Identity, non-Contradiction and Excluded Middle in every individual cognitive operation [तदलं तत् परिच्छिन्नति (identity) अच्छद व्यवच्छिन्नति (non-contradiction) लक्षोय-प्रकाराभावं च सूचयति (excluded middle) इति एकप्रमाण-व्यापारः—Jayanta, Nyáya-Manjari, प्रमाणहेतुव्यवहारखण्डम्]

Perception :—The conditions of perception, and its range and limits, were carefully studied. The minima sensible (*e.g.*, the minimum visible, the Trasarenu, the just perceptible mote in the slanting sunbeam), the infra-sensible (अनुहृतस्य सूक्ष्म, sometimes termed अवौद्धिक the obscured (अभिभूत, *e.g.* a meteor in the mid-day blaze), and the potential (अनुहृतता), are distinguished; but finer instruments of measurement were wanting, and this was a principal cause of arrested progress. It may be noted that the measurement of the relative pitch of

musical tones was remarkably accurate and original (*vide my Paper on Hindu Mechanics and Physics*).

Observation (दर्शन—Váchaspati and Udayana) :—The entire apparatus of scientific method proceeded on the basis of observed instances carefully analysed and sifted. This was the source of the physico-chemical theories and classifications, but in Anatomy, the Hindus went one step further ; they practised dissection on dead bodies for purposes of demonstration. Ingenious directions are given, e.g., the body must be first disembowelled and wrapped round with the kusa and other grasses, then kept immersed in still water for seven days, after which the medical student should proceed to remove the layers of the skin with a carefully prepared brush made of the fresh elastic fibres of green bamboos ;—which will enable the tissues, vessels and ducts to be observed. *Post-mortem* operations as well as major operations in obstetric surgery (the extraction of the foetus, etc.) were availed of for embryological observations (e.g., it is stated as a result of observation that the rudiments of the head and the limbs begin to appear in the foetus in the third month, and are developed in the fourth ; the bones, ligaments, nails, hair, etc. becoming distinct in the sixth) ;—and also embryological theories, e.g., the indication of sexual character in the second month by the shape of the foetus, the shape of a *round joint* indicating the male sex, and an

elongated shape as of a muscle the female sex (cf. Charaka, Sústrasthána, Chap. IV,— रितीयि नाति चनः सम्बद्धते पित्तु देहसंकुर्दं वा । तत्र चनः पित्तुः पुरुषः ज्यो देवी चर्मुदं चपुरुषम् । Chakrapáni notes : चनः कठिनः । पित्तुः चन्द्राकारः । देवी दीप्तिसुपेशाकारः । चर्मुदं वर्णोद्धतम् loc. cit.) In

Phonetics (as in the Prátisákhya-s, *circa* 600 B. C.), in Descriptive and Analytical Grammar (as in Pánini), and in some important respects in Comparative Grammar (as in Chanda's and Hemachandra's Grammars of the Prákrita Dialects), the observation was precise, minute and thoroughly scientific. This was also the case in Materia Medica, and in Therapeutics, especially the symptomatology of diseases. In Meteorology, the Hindus used the rain-gauge in their weather forecasts for the year, made careful observations of the different kinds of clouds and other atmospheric phenomena (*e. g.*, they give the heights of the clouds, the distance from which lightning is ordinarily visible, or the thunder is heard, the area of disturbance of different earth-quakes, the height to which the terrestrial atmosphere extends, etc., *vide* Varáhamihira, Srípati, and the authorities quoted by Utpala). In Astronomy, the observation was, generally speaking, very defective as in the determination of the solar and the planetary elements, and this was probably due to the lack of practical interest, but the determination of the lunar constants entering into the calculation of lunar periods and eclipses, matters in

which the Hindus had a practical ceremonial interest, reached a remarkable degree of approximation (much above Graeco-Arab computations) to the figures in Laplace's Tables, which can only be explained by the circumstance that in the case of these constants the Hindus carried out for more than a thousand years a systematic process of verification and correction by comparison of the computed with the observed results (like the navigator's correction of the course of the ship at sea), a process which was termed इन्विटेश्न. In Zoology, the enumeration of the species of Vermes, Insecta, Reptilia, Batrachia, Aves, etc., makes a fair beginning, but the classification proceeds on external characters and habits of life, and not on an anatomical basis. In Botany, the observation was mainly in the interests of Materia Medica, and the classification was as superficial as possible. (*Vide* my paper on the Hindu Classification of Plants and Animals).

Experiments :— Experiments were of course conducted for purposes of chemical operations in relation to the arts and manufactures, e. g., Metallurgy, Pharmacy, Dyeing, Perfumery and Cosmetics, Horticulture, the making and polishing of glass (lenses and mirrors of various kinds are mentioned, the spherical and oval उच्च and चतुर्ष, being well-known—Pliny indeed mentions that the best glass ever made was Indian glass). And the

results of such experiments were freely drawn upon for building up scientific hypotheses and generalisations. But of experiment as an *independent* method of proof or discovery, the instances recorded in books are rare. I may note one interesting example in Udayana's Kiranávali, relating to the weight of air. Udayana argues that air must be a distinct and independent Bhuta, for if air were a form of the Earth-Bhuta, it would have weight, and it has none. To prove the absence of weight, he refers to an experiment. A small bladder made of a thin membrane, filled with air, will not cause a greater descent in the scale than the same bladder weighed empty. Hence the air possesses no weight. Then Udayana makes an interesting statement. It may be objected, he says, by one who accepts the weight of air—that this argument is inconclusive. For a counter-experiment may be suggested. The balloon filled with smoke (or gas, अग्नि), rises in the air, whereas the air-filled balloon comes down. This would go to show that air has weight. Udayana replies that this would only show that both smoke (or gas, अग्नि) and air have no weight. The Hindus appear to have been ignorant of the principle of Archimedes. Vallabhácháryya in the Lílavatí, it is true, speaks of a peculiar resistance to sinking (or gravity) exercised by water, which explains the tendency in certain objects to float

or to come up to the surface of the water, but the description shows that he had no clear ideas on the subject.

Mathuránátha, again, states that the determination of the degree of purity (the carat) of gold by rubbing against the assaying stone and observing the character of the yellowish streak against the black smooth background, is only an indirect means of ascertaining weight (गुरुत्ववैज्ञानिक् lit. specific gravity)—which seems to suggest that there was a more direct means of arriving at the latter. Probably this refers to the common Indian method of comparing the lengths and weights of wires of uniform thickness that can be formed by drawing different pieces of gold through the same diamond bore. I think it may be regarded as fairly certain that the Hindus were ignorant of Archimedes's discovery, an ignorance which, at any rate, they could not have well borrowed from the Greeks, no more than they could have thus borrowed their knowledge of things unknown to the Greeks themselves. [Cf. Udayana, Kiranávali :—

बायुगिरपत्तम्, किं च (बायोः) गुरुत्वमपि स्यात् । न च पवनापूरितस्य चर्यापुटकादेः अपूरणदशातः अधिकं अवलम्बनम् । उक्षीय-मागस्य च मापूरितेन इदम् अग्रेकाण्डिकं इति चेत् । न । असं च मृदशायाः । तत्रापि गरिमविशेषहेतोरवनतिविशेषस्य अप्रसोतेः ॥—cf. Vallabhbá-cháryya, Lílavatí—गुरुत्वविशेषेऽपि पावाणासादुप्रभृतिषु अच्छी-अप्लव्यन नियमवत् अद्वृहितुक्ता साम्बेदिपि पतनोत्पतन-नियमो भविष्यतीति ॥

चेत् न । जगापोदमनं जगेन भारत्य पवनप्रतिष्ठां उग्राक्षनं एतद
जग्यत् भीमस वस्त्रिदेव पवनप्रतिष्ठामर्थात् । हटहितुकमिव जग्यन्ते
उग्राक्षम्]—cf. Mathuránátha, वस्त्रिकर्णवाहरक्ष on Gan-
gesa's Tattvachintámani—तस्म (निष्ठोपलक्ष) न सूष्टु-
पौत्राभिष्वङ्गदत्तं किञ्चु पीतशारा गुदवदेवत्वाम्बद्ध कलमिव तस्म ।

Fallacies of Observation—Mal-observation and Non-observation :—These were carefully studied in relation to errors of observation, and Hallucination (अभ्यास, आरोप)—which were ascribed to three causes :—(a) Dosha, दोष, defect of sense organ, as of the eye in jaundice, or of the skin in certain forms of leprosy (leading to tactile insensibility, cf. Susruta) or defect of necessary stimulus, e.g., too faint light, or undue distance or nearness, in vision ; (b) Samprayoga, सम्प्रयोग, presentation of a part or an aspect instead of the whole.; and (c) Sanskára, संस्कार, the disturbing influence of mental predisposition. e.g., expectation, memory, habit, prejudice, etc.

The Doctrine of Inference:—Anumána (Inference) is the process of ascertaining, not by perception or direct observation, but through the instrumentality or medium of a mark, that a thing possesses a certain character. Inference is therefore based on the establishment of an invariable concomitance (Vyápti, व्याप्ति) between the mark, and the character inferred. The Hindu Inference (Anumána) is therefore neither merely formal nor merely material, but a combined Formal-Material

Deductive-Inductive Process. It is neither the Aristotelian Syllogism (Formal-Deductive Process), nor Mill's Induction (Material-Inductive Process), but the real inference which must combine formal validity with material truth, inductive generalisation with deductive particularisation.

An inference admits of a rigorous formal statement,—in the shape of five propositions, for dialectical purposes (*i.e.*, in demonstrating to others), or of three propositions when the inference is for one-self (स्वार्थानुमान):—(1) the probandum, the statement of the proposition to be established (प्रतिष्ठा, साध्यनिषेध, e.g., yonder mountain is fiery (say, an active volcano); (2) the reason, the ascription of the mark (ऐतु, लिङ्गव्यपदेश).—e.g., for it smokes; (3) now, the general proposition, stating the invariable concomitance which is the ground of the inference,—clenched by an example bringing home the responsibility of the reasoner to establish a real relation, e.g., whatever smokes is fiery, as an oven; (उदाहरण);—(4) next, the application, the ascertainment of the existence of the mark in the present case (उपय) e.g., yonder mountain smokes;—(5) finally, the conclusion, the probandum proved (निगमन), e.g., yonder mountain is fiery.

1. Yonder mountain is fiery.
2. For it smokes.
3. Whatever smokes is fiery, as an oven.

-
4. Yonder mountain does smoke.
 5. Therefore, yonder mountain is fiery.

For inference for oneself, only the first three or the last three propositions, are held to be sufficient.

The Hindu Anumána, it will be seen, anticipates J. S. Mill's analysis of the syllogism as a material inference, but is more comprehensive;—for the Hindu Udaráharana, the third or general proposition with an example, combines and harmonises Mill's view of the major premise as a brief memorandum of like instances already observed, fortified by a recommendation to extend its application to unobserved cases, with the Aristotelian view of it as a universal proposition which is the formal ground of the inference. This Formal-Material Deductive-Inductive process thus turns on one thing—the establishment of the invariable concomitance (*साम्बन्धः*) between the mark and the character inferred,—in other words, an inductive generalisation. The question is—what is our warrant for taking the leap from the observed to unobserved cases? Under what conditions are we justified to assert a Universal Real Proposition on the basis of our necessarily limited observation?

The Chárváka view:—Among the Chárvákas there were two classes, the cruder school of materialists who accepted perception (*प्रत्यक्षः*) as a valid source of knowledge, as well as the reality of

Natural Law (व्यभाव), and the finer school of sceptics, who impugned all kinds of knowledge, immediate as well as mediate, and all evidence, Perception as well as Inference, *vide* Jayanta's reference in the Nyáya-Manjarí to सुशिद्धितचार्याकाः; also चार्वाकधूतस्तु अथातकर्त्तव्यात्मा इति प्रतिज्ञाय प्रमाणप्रमेयसंख्यालक्षण-नियमाश्रयकारणोयत्वमेव व्याख्यातवान्—A'hnika I, Manjarí.

The Chárvákas hold that the principle of causality, which the Buddhists assume to be a ground of an induction (व्याप्ति) is itself an induction (a case of Vyápti), which amount to reasoning in a circle (चक्रक) ; that every inference is based on an unconditional invariable concomitance which itself must be inferred, as universal propositions cannot be established by our limited preceptions, and thus there is a regressus ad infinitum (चनादि परम्परा) ; and that the nexus between cause and effect, or between the sign and the thing signified (e.g., smoke and fire) is only a mental step or subjective association based on former perception, a mental step which by accident is found justified by the result in a number of cases.

The Buddhists—their Analysis and Vindication of Inference :— The Buddhists, however, take their stand on the principle of the Uniformity of Nature (प्रतिबन्ध, व्यभाव प्रतिबन्ध, Nyaya-Vindu). This uniformity, for scientific purposes, has to be divided into two different relations,—(1) the uniformity of succession in the relation of cause and effect, e.g.,

of smoke to fire (कार्यकारणमात्र, तदृतपत्ति, Nyaya-Vindu); (2) the uniformity of co-existence (in the form of co-inherence in the same substrate) in the relation of genus and species, e.g., the relation of invariable concomitance expressed in the proposition,—all Sinsapás are trees,—which is not a relation of causality, but of co-existence or co-inherence in the same substrate (*i.e.*, the co-inherence of the generic qualities of a tree with the specific characters of a Sisu tree, in this particular individual before me, a Sisu tree),—a relation which may be termed essential identity (सादात्मा, समात्र—Nyaya-Vindu). To these two, the Buddhists add a third ground of inference, non-perception of the perceptible (अनुपलक्ष्य इत्यानुपलक्ष्य), which is employed in inferring the absence (प्रतिषेध) of a thing from the non-perception of something else. In all cases of inference based on the Uniformity of Nature, the relation is that of inseparableness or non-disjunction between the mark and the character inferred. The question is—how is this inseparableness (अविचाभाव) ascertained, and what is the warrant of our belief in it, in these cases?

Ascertainment of Inseparableness or Non-disjunction : Buddhist Account :— First take the case of causation. The cause is the invariable antecedent of the effect. What is meant is that the specific effect (with all the distinctive and relevant accompaniments, कार्यविशेष) is invariably preceded by a

specific cause (कारणविशेष). It is not that clouds always lead to rain, or that floods in the river valley always imply rain in the hills higher up. But this particular conjunction of antecedent circumstances (e.g. the appearance of a particular kind of clouds accompanied with flashes of lightning, the roll of thunder and flights of Valákás—driven by the wind from a particular quarter of the horizon, and ascending in black masses, etc.) is as a rule the precursor of a particular assemblage of rain effects (rain with particular accompaniments). Again, this particular kind of flood (overflowing of the river banks accompanied with muddy discoloration of the water, rapid currents, the bearing down of tree trunks, etc.) is always preceded by rain in the hills higher up (though, no doubt, other case of floods in a river may be due to a breach in an embankment or the melting of the snows). In other words, the Buddhists (and the earlier Nyáya Schools) avoid the difficulty arising from the plurality of causes by taking into consideration the accompanying phenomena, which, if properly marked, would always point to a specific cause of a specific effect.

I quote Nyáya authorities, but this device to obviate the plurality of causes is common to the early Nyáya and the Buddhistic systems.

पूर्ववत् । यत् कारणेन कार्यमनुसूयते । उदाहरणम्—
मेवोऽल्ला भविष्यति डिप्रिति कारणेन कार्यानुभावम् । कर्त

पुनरस्य प्रयोगः । उद्दिमतः एते मेघाः गच्छीरभ्यनिवस्ते सति बहुवक्षाकाः-
वस्ते सति अधिरप्रभावस्ते सति उद्धतिमत्त्वात् उद्दिमन्ते घवत् ।

श्रेष्ठवत् (यद कार्येण कारणमनुभूयते)—उदाहरणम्—

उपरिहार्दमहेशसम्भिनी नदीकीर्तिः श्वोप्रत्ये सति पूर्वकक्षकाढादि-
बहुवक्षे सति पूर्णत्वात् पूर्णउद्दिमन्तदीदिति । (Uddyotakára,
Chap I. A'hnika 1, Sútra 5). Váchaspati puts this
clearly :—यद्यपि कारणमावे अभिचरति कार्योत्पादं तथापि याद्युर्थं
न अभिचरति तच [नपुणे] प्रतिपदा भवितव्यम् । अवया धूममावमपि वक्ति-
मन्ता अभिचरतीति न धूमविशेषो गमकी भवेत् । In other words,
a single condition called a cause is not invariably succeeded by the effect, nor does the effect
phenomenon in general point to any particular cause as antecedent, for there may be a plurality of
causes of a general effect. The skilful observer
will therefore select the full complement of
causal conditions, which is invariably succeeded by
the effect,—and also the specific effect (e.g., धूमविशेष) which points to a specific causal antecedent.
Compare also Jayanta :—we infer an effect from a
specific assemblage of causes—न च कारणमावस्य हेतुलं द्रूमी
थेनाम्य अभिचारः स्यात् । अपि च विशिष्टमेव कारणं हेतुः । न च
कारणविशेषो दुरवगमः । गच्छीरगच्छिंतारभ्यनिर्भवित्वगिरिहरा: दीखम्-
गवलम्बालतमालमलिनस्तिवः...हर्दिं अभिचरन्तीह तेव प्रायः पवीमुचः ।
अनभ्युपगमे चेदमनुमानस्य जीवितम् । न स्वाद्यमविशेषाचामपि वीक्षुम-
पत्तिः । Similarly we infer a specific cause from
a specific assemblage of effects :—श्रेष्ठदिति यद कार्येण

काद्यमनुभीयते यथा नदीपूरेष उपरित्वे देशे छाईरिति । इटिमत्-
पृष्ठदेशस्तु द्वा पृथ्वी नदी फेनिलकलुषत्वादिविशिष्टपूरोपेतत्वात् । यसु
सेतुभङ्गिमविलयनादिनापि नदीपूरीपपतिर्ह द्वा इति तत्रापि 'चक्षते—
प्रमातुरपराधीइयं विशेषं यो न पश्यति ।
नाशुमानस्य दोषोऽस्मि प्रमेयाव्यभिचारिणः ॥

(Nyáya-Manjari, A'hnika 2, on Gotama Sútra
5, A'hnika 1, Chap I.)

A specific assemblage of causes, therefore, has only one specific assemblage of effects, and *vice versa*. Of course, the observer is to find out the essential or relevant features (as distinguished from the irrelevant ones) which, being included, will enable him to specify the particular cause of the particular effect.

Now this being premised to be the exact meaning of the inseparableness or non-disjunction in the case of cause and effect, we come to the question with which we started—how is this relation to be ascertained or established between two phenomena or assemblages of phenomena? Obviously, mere observation of their agreement in presence (जन्मय) and their agreement in absence (अजन्मय) is no help in the matter. Take a concrete example. The ass is customarily employed to bring the fuel with which fire is lighted. In a hundred cases you have observed the ass among the antecedents of smoke. In a hundred cases you may have observed that 'when there is no ass, there is no smoke.' This is no

warrant for concluding a relation of cause and effect between an ass and smoke. It may be that you happen to have never observed smoke without an antecedent ass, or an ass without smoke following. Even this is of no avail. It is not agreement (unbroken and uniform though it be) in presence, or in absence, or in both, that can settle the matter. There is one and only one way of ascertaining the causal relation. Suppose *A* with certain accompaniments is found to precede *B* immediately. Now if *A* disappearing, *B* disappears, even though all other antecedents remain and there is no other change in the case, then and then only can the causal relation be ascertained. It is not a mere table of positive instances or negative instances (अदर्शनाम न दर्शनात्);—it is this method which we may term the Method of Subtraction (the Method of Difference in its negative aspect) that is the only exact and rigorous scientific Method. Such was the statement of the earlier Buddhists (cf. Uddyotakára's and Váchaspati's report of the Buddhist Doctrine of Inference—स हि प्रतिवेद्यो न दर्शनमादावस्थिः।

तादात्मात्मदुत्पत्तिनिवृत्तिः एव प्रतिवेद्यः। यदाह कार्यकारण-
भावादा स्वभावादा नियमकात्। अविलाभावलियसोऽदर्शनाम न दर्शनात्—
—a Buddhist Káriká quoted in Váchaspati, Udayana,
Śrīharsha, Mádhava, etc.)—कार्यकारणभावस्य इदम्—अस्मिन्
सति भवति—सत्सु अपि तद्वेतु अस्मिन्नसति न भवति—एवमाकारः।
न अन्यव्यतिरेकाभ्यामतिरिच्छते।... (एवं तादात्मामपि विपर्ययै बाधक

प्रमाणोपपत्त्वा निषेदव्यगः...तत्कात् सादात्मातदुत्पत्तिभ्यामेव प्रतिवन्धी
नान्यतः ।—Váchaspati, Tátparyyatíká, Chap I, Añnika
1, Sutra 5, अनुमानलक्षणम्—व्याप्तिरहीनायः ।

But the canon in this form is not sufficiently safe-guarded against possible abuse. Two points have to be emphasised :—(1) It must be carefully observed that no other condition is changed, (2) that the appearance and disappearance of *A* must immediately precede the appearance and disappearance of *B*. The definition of a cause is based on two fundamental characters, (1) the unconditional invariableness of the antecedence, and (2) the immediateness of the antecedence. The canon of the Method of Difference must therefore be stated in such a form as to emphasise each of these aspects. And one main difficulty in the practical application of the canon is that along with the introduction or sublation of an antecedent, some other phenomenon may be introduced or sublated unobserved. As a safe-guard against this radical vitiation of the Method, the later Buddhists formulated the canon of a modified Method, termed the Panchakárani, a Joint Method of Difference, which combines the positive and the negative Methods of Difference (the Method of Addition and the Method of Subtraction) in a series of five steps, and which equally emphasises the unconditionality and the immediateness of the antecedence as essential moments of the causal relation. This is

neither agreement in presence, nor agreement in presence as well as absence (the foundation of J. S. Mill's Joint Method of Agreement), but the Joint Method of Difference. The Panchakárani runs thus :—

The following changes being observed, everything else remaining constant, the relation of cause and effect is rigorously established :—

First step—The 'cause' and the 'effect' phenomena are both unperceived.

Second step—Then the 'cause' phenomenon is perceived.

Third step—Then in immediate succession, the 'effect' phenomenon is perceived.

Fourth step—Then the 'cause' phenomenon is sublated or disappears.

Fifth step—Then in immediate succession, the 'effect' phenomenon disappears.

Throughout, of course, it is assumed that the other circumstances remain the same (at least the relevant or material circumstances).

This Panchakárani, the Joint Method of Difference, has some advantages over J. S. Mill's Method of Difference, or what is identical therewith, the earlier Buddhist Method; and the form of the canon bringing out in prominent relief the unconditionality and the immediateness of the antecedence, is as superior from a theoretical point of view to J. S. Mill's canon,

and is as much more consonant than the latter to the practice of every experimenter, as the Hindu analysis of Anumána as a Formal-Material Deductive-Inductive Inference is more comprehensive and more scientific than Aristotle's or Mill's analysis of the Syllogism (or Mediate Inference).

But even the Panchakárani is no sufficient answer to the question with which we started. The Panchakárani is only a method ; it shows only how in a particular case the relation of cause and effect is to be established (प्रतिबन्धयहीपाय). But we want more than this—we require a warrant for the process. The Buddhists therefore supply the following proof of the Method :—Doubt is legitimate, but there is a limit to doubt. When doubt lands you in an unsettlement of a fundamental ground of practice, and would thus annul all practical exercise of the will, the doubt must cease ; else the doubt would be suicidal or sophistical. In this particular case, when the Panchakárani is satisfied, the antecedent in question must be the cause, for there is no other antecedent to serve as cause ; the proof is indirect but rigid. If this be not the cause, there is no cause of the phenomenon. It was not, and it begins to be, without a cause ; which would be a contradiction of the rational ground of all practice, for all volitional activity proceeds by implication on the principle of causality. If things could happen

without a cause, all our motives to action would be baffled. The link between a presentation and the instinctive volitional reaction would snap, and the circuit of consciousness would be left incomplete. In fact, the Buddhists go further; they hold causal efficiency (पूर्वकिया) to be of the essence of empirical (relative) Reality. The proof of the Joint Method of Difference, then, lies in a strict application of the principle of causality in its negative form (*viz.*, there can be no phenomenon without a cause) and the truth of this last is guaranteed by the same ultimate criterion of empirical (relative) Reality as the truth of Perception itself, *viz.*, the correspondence between the rational and the practical activity of the self.

But invariable concomitance (or non-disjunction), the Buddhists argue, has another form, *e.g.*, the relation of the genus to the species. We may have perceived a hundred instances of the association of certain characters with certain others; we may also have never perceived the former when the latter are absent; but this would not enable us to generalise and establish invariable and unconditional co-existence. We must be first satisfied that there is identity of essence (वादात्मा स्वभाव). It is only when we perceive that the characters of a Sinsapá are co-inherent with the generic characters of a tree in the same individual object (a Sinsapá tree before me), and when we further

perceive that the characters are held together by the relation of identity of essence, that we can say that all Sinsapás are trees. For as there is identity of essence, a Sinsapá would not be a Sinsapá, if it were not a tree. It would lose its self-identity which is a contradiction. Hence the relation of identity of essence (तादात्मा स्वभाव), as in the relation of the species to the genus, is the sole ground for establishing uniformity of co-existence (प्रतिवृत्त, स्वभावप्रतिवृत्त).

(For the Buddhist Method of Induction, in its later form, the Panchakárani, vide Sarvadarsana Sangraha—Buddhist reply to the Chárváka attack on Inference :—

यद्यथायि अविनाभावो दुर्बोध इति तदसाधीयः। तादात्मप्रदृत-
प्रतिभ्यासविनाभावस्य सुश्चात्मतात्। तदुक्तं—कार्यकारणभावात् वा
ख्यभावात् वा नियामकात्। अविनाभावनियमोऽदर्शनाप्त न दर्शनात्।
As for the Nyáya view अन्वयव्यतिरेकी अविनाभावनियायको
इति।—the Buddhist objects—ननु पचे साध्यसाधनयोरव्यभिचारी
दुरवधारणः भवेत्। भूते, भविष्यति, वर्तमाने अनुपलभ्यमाने च व्यभिचार-
शङ्खाया अनिवारणात्।—the Nyáya retorts ननु तथाविचर्याले
तापकेऽपि मने व्यभिचारशङ्खा दुष्परिहरा इति।—the Buddhist
answers—मेर्वं बोचः, विनापि कारणं कार्यमुतपद्यताम् इत्येवं-
विद्यायाः अङ्गायाः व्याधातावधिकतया निःतत्वात्। तदेव हि
आश्चर्येत् अविनाभावमाने व्याधातादयः नावतरेयुः। तदुक्तं व्याधाता-
विद्याशङ्खा इति। तथात् तदुपपत्तिनिश्चयेन अविनाभावो निश्चयते।
तदुपपत्तिनिश्चयस्य कार्यहेत्वोः प्रत्यच्छीपक्षात्मानुपलभ्यपक्षक्लिप्तमः।

कार्यक उत्पन्नः प्रानतुपलक्ष्यः, कारकीपलक्ष्ये स्तुति उपलक्ष्यः, उपलक्ष्यस
पलक्ष्यात् कारकाशुपलक्ष्यात् अशुपलक्ष्यः इति पलक्ष्याकारका चूम-चूमध्यवद्योः
कार्यकारकमावः निश्चयते । तथा तादात्मानिवर्तेन अपि अविनाभावः
निश्चयते । यदि शिश्पा उच्चलम् अतिपतीत् साक्षात्मनेव अस्तात् इति
विषये बाधकप्रडत्तेः । अप्रहस्ते तु बाधके भूयः सहभावीपलक्ष्येऽपि
अभिचारमहायाः की निवारयता । शिश्पाहृष्टयोष तादात्मानिवर्त्यः
इत्येवं शिश्पा इति साक्षात्माधिकरणलक्ष्यात् उपपद्यते । तस्मात् कार्या-
लानि कारकम् आक्षात्म अशुभापयत् इति सिद्धम् । Sarvadarsana
Sangraha, Bauddha-Darsanam Vide also Sridhara
Kandali.

The Nyāya Doctrine of Inference :—The Nyāya easily demolishes the Buddhist contention about identity of essence. The Nyāya writers, being realists, do not impugn the reality of the genus (जाति) like the nominalists or the nominalistic conceptualists ; but they point out that the inseparableness (or non-disjunction) in such cases can only be established by the experience of unbroken uniformity (अव्यविचारित्वं i.e., by अव्यवविरेकी, दर्शनादर्शने). Uniform agreement in presence with uniform agreement in absence,—not the mysterious identity of essence irresistibly perceived in any individual case or cases—is the only basis for constituting genera and species in Natural Classification. Indeed some of the later Nyāya writers point out that individuals do not always possess in Nature all the characters that go to form the definition of the class to which they are referred.

Similarly, as regards the relation of cause and effect, a *nexus* is sometimes fancied to be perceived, a power in the cause to produce the effect (जाति), or an ultimate form (जाति सौचा), which is supposed to be present, whenever the effect (quality or substance) is produced (cf. Bacon's view of the 'Forms' of Simple Qualities). All this is neither a matter of observation nor of legitimate hypothesis. There is nothing except the invariable time-relation (antecedence and sequence) between the cause and the effect. But the mere invariableness of an antecedent does not suffice to constitute it the cause of what succeeds ; it must be an unconditional antecedent as well (अन्वयादिहशुभ्य नियतपूर्व-वर्त्तिः, being the definition of कार्यकारणमात्र). For example, the essential or adventitious accompaniments of an invariable antecedent, may also be invariable antecedents, but they are not unconditional but only collateral and indirect, in other words their antecedence is conditional on something else (अस्त्रात्मकोऽप्य). The potter's stick is an unconditional invariable antecedent of the jar, but the colour of a stick, or its texture or size or any other accompaniment or accident, which does not contribute to the work done (so far as we are considering it) is not an unconditional antecedent, and must not therefore be regarded as a cause. Similarly, the co-effects of the invariable antecedents, or what enters into the production of these

co-effects, may themselves be invariable antecedents but they are not unconditional, being themselves conditioned by those of the antecedents of which they are effects. For example, the sound produced by the stick, or by the potter's wheel, invariably precedes the jar, but it is a co-effect,—and *A'kása* (ether) as the substrate, and *Váyu* (air) as the vehicle, of the sound, enter into the production of this co effect, but these are not 'unconditional' antecedents, and must therefore be rejected in an enumeration of conditions or causes of the jar. Again, the conditions of the conditions, the invariable antecedents of the invariable antecedents, are not unconditional. The potter's father is an invariable antecedent of the potter who is an invariable antecedent of the jar, but the potter's father does not stand in a causal relation to the potter's handiwork. In fact, the antecedence must not only be unconditionally invariable, but must also be immediate (*चत्वारिंशतपूर्वकालावच्छेदेन कार्यदेशे सत्त्वम्*). Finally, all seemingly invariable antecedents which may be dispensed with or left out, are *ipso facto* not unconditional, and cannot therefore be regarded as causal conditions ; in short, nothing that is unnecessary is unconditional ; for this class, *vide Visvanátha*—*नियतावस्थाकपूर्वभाविनः अवश्यक्तस्त्रियतपूर्ववर्जित एव कार्यसम्बोधे ।* *तत्त्वज्ञम्* (*तत्त्विक्ष्णः*) *चत्वारिंशं—Visvanátha, Siddhánta Muktávali*, on Sloka 20. For example, it is the custom to point to spatial position or direction with the

fingers, but finger-pointing, though invariably present, is not causally related to the perception of direction or spatial position, because we can imagine such perception without finger-pointing, (अन्यथासिद्धतया चकुर्या निर्देशस्य दिक्प्रत्यक्षतेन न स्वाभाविकः सम्बन्धः, Váchaspati, Tátparyya-Tiká, Chap, I, A'hniká 1, Sutra 5,—this shows that the doctrine of अन्यथासिद्धशब्द was long anterior to Gangesa).

[Visvanátha in the Bhásha-Parichchheda mentions five kinds of अन्यथासिद्ध, conditional antecedents—(1) यैति सहपूर्वभावः (2) यस्य वा कारणमादाय (पूर्वभावः), (3) अन्यंप्रति पूर्वभावे ज्ञाते यत्पूर्वभावविज्ञानम्, (4) अनकं प्रति पूर्ववर्त्तिम् अपरिज्ञाय यस्य (पूर्ववर्त्तिम्) न गच्छते, and (5) अथापि यत् नियतावश्यकपूर्वभाविनः अतिरिक्तम् भवेत् (एतेषु पञ्चु चावश्यकस्तसी—Slokas 19 and 20), यस्य स्वातन्त्र्योऽप्य अन्यथाव्यतिरिक्तो न सः किन्तु स्वकारणमादायेव अन्यथाव्यतिरिक्तो गच्छते तद्व्यथासिद्धम्, Siddhánta Muktiávali, loc. cit.—The Dinakarí points out that the first two cases are comprehended under the formula इतरान्यथाव्यतिरिक्तप्रयुक्तान्यथाव्यतिरिक्तशालिलम्। There are several classifications of these irrelevant antecedents (अन्यथासिद्धः); I quote one of the best known].

The unconditional (अन्यथासिद्धशब्द) as interpreted in this comprehensive sense is a far more fruitful conception than Mill's, and is well adapted to its work—the elimination of the irrelevant factors in the situation. In the end, the discrimination of what is necessary to complete the sum of causes, from what

is dependent, collateral, secondary, superfluous or inert, (*i. e.* of the relevant from the irrelevant factors) must depend on the test of expenditure of energy. This test the Nyāya would accept only in the sense of an operation analysable into molar or molecular motion (परिच्छन्द एव भौतिको व्यापारः करोवर्धः—जटीन्द्रियसु व्यापारो नासि, Jayanta, Manjari, A'hnika I); but would emphatically reject, if it is advanced in support of the notion of a mysterious causal power or efficiency (शक्ति). This is a peculiarity of the Nyāya—its insisting that the effect is only the sum or resultant of the operations of the different casual conditions—that these operations are kinetic, being of the nature of motion, in other words holding firmly to the view that causation is a case of expenditure of energy, in the kinetic form,—but at the same time absolutely repudiating the Sāṅkhya conception of power or productive efficiency as metaphysical or transcendental (शक्तीन्द्रिय), and finding nothing in the cause other than an unconditional invariable complement of operative conditions (कारणसामयो) and nothing in the effect other than the consequent phenomenon which results from the joint operations of the antecedent conditions (समुद्दितसम्बन्धकारकगिकरः परिच्छन्द एव—Jayanta—सामयो कार्ये—सामयीकार्यते तु कार्यमस्तु किमन्तराक्षरांपूर्णवा शक्ता—Jayanta, ibid, A'hnika, 1, शक्तिगिराकरणम्—it may be noted that the Nyāya, while repudiating transcendental power (Sakti) in the mechanism of nature

and natural causation, does not deny the existence of metaphysical conditions like merit (धर्म,) which constitute a system of moral ends that fulfil themselves in and through the mechanical system and order of Nature—*vide* Jayanta, अतौनिद्रयं किमपि कारणं कस्तितमेव चर्यादि—A'hnika I, शक्तिनिराकरणम्).

The causal relation, then, like the relation of genus to species, is a natural relation of concomitance (आस्ति स्वाभाविकः सम्बन्धः—Váchaspati) which can be ascertained only by the uniform and uninterrupted experience of agreement in presence and agreement in absence, and not by deduction from a certain *a priori* principle like that of Causality or Identity of Essence.

Nyáya objection to the Buddhist Method of Difference as a means of ascertaining causality.

Take for example the Buddhist deduction of Causality in any particular conjunction by means of the negative Method of Difference, or of the Panchakárani. The ascertainment of the causal relation by these Methods is open to the following objections :—(1) The unconditionality of the antecedent cannot possibly be ascertained. As the Chárváka rightly points out, the Methods enable you to eliminate irrelevant antecedents that are or can be perceived ; but the introduction or sublation of latent or undetected antecedents can be imagined against which the Method of Difference is powerless. In the case of the production of

smoke, for example, by fire,—what if I say that an invisible demon intervenes in every case between the fire and the smoke, that this demon (पितॄष) is the immediate antecedent and real cause of the latter, and that the fire is an accident which, in every such case, is brought about by its own causal antecedents ;—in saying this, I do not go counter to the principle of causality and am landed in no contradiction (न्यायात्) such as strikes at the very roots of all practice, or baffles the completed circuit of consciousness, however much I may violate probability.

(2) In the second place, even supposing that the fire, in this particular case (which satisfies the Method of Difference rigidly) is ascertained to be the cause of the smoke, how can I know that fire is the cause in other cases, or that there is no other cause. You will perhaps argue that if there were an *indefinite* number of causes of the same specific phenomenal effect, it would violate the principle that phenomena are all conditioned, *i.e.*, exist only under certain conditions (कावाचित्कर्त्त्व),—which is more comprehensive than the principle of causality, and the contradiction of which equally overthrows all rational practical activity. Yes, I accept the conditionality of phenomena, but this is not violated by supposing that one specific assemblage of phenomena has more than one cause. It is true that if you suppose such plurality of causes, you cannot establish the invariableness of

the particular conjunction (green-wood fire and smoke) which your Method of Difference fixes upon as a case of cause and effect ; in other words, with your special principle of Causality so restricted, and without any general principle of Uniformity of Nature to fall back upon, you cannot ascertain, from the present case, or from any number of similar cases that you may have observed, that *all* green-wood fires are followed by smoke ; *i.e.*, you are helpless in demonstrating with apodietic certainty (or ascertaining indubitably) the relation of cause and effect. But this is an objection against your own position, not mine. Why not admit at once that certain phenomena are naturally connected (as invariable concomitants or antecedents) with other phenomena, and take your stand on observed concomitance (uniform and uninterrupted experience of agreement in presence as well as absence) without assuming causality as an *a priori* principle and making deductions therefrom, and without the trouble of ascertaining the relation of cause and effect in every individual case. I am free to admit that theoretical objections of irresistible force (like those of the Chárváka Sceptics) can be urged against this ascertainment of universal invariable and unconditional concomitance (व्यापकव्याप्ति) on the basis of mere observation. Doubts of this kind can no more be laid by my view of the matter than by your canons of causality and essential

identity (तदृत्पत्ति and तात्त्वाभ्या). Ultimately we all have to fall back on the rational practice of thinking persons (प्रियादर्शः), and such persons are always content to act on practical certitude instead of hankering after an unattainable apodictic certainty in the affairs of life (प्रामाणिकखोक्याबामनु-पात्रता यथादर्शं अहमोयम्). This same practical certitude is also the ultimate warrant of the Deductive-Inductive Inference by which we ascertain the characters of things without direct perception and through the medium or instrumentality of a mark.

[To the earlier Buddhist canon of the Method of Subtraction, i. e., the negative Method of Difference, Uddyotakara and Váchaspati of the Nyáya School pertinently and acutely object as follows :—

सर्वं यत् किञ्चित् क्लिन्त् हट्टं तत्त्वं यत् प्रतिबन्धः; तदिदः तस्य तत् नमकं तत् इति अनुवागीमः। स एव तु मतिबन्धी न तात्त्वं तदृत्पत्त्या सम्भवति। क्वा पुनरियं तदृत्पत्तिः। खूमस्य किं बङ्गानन्तरं भावः। स ताहृष्टः अस्मि रासभस्यापि। तत्प्रतिक्षीडपि खूः सात्। अयं तदनन्तरमेव भावः, न च रासभानन्तरं भवद्वयि तदनन्तरमेव भवति। तज्जिन् सति चपि चसति चप्तो तदभावात्। चक्षति चपि तज्जिन् सत्त्वादेवनवति चक्षो तदभावात्। चक्ष चक्षयि खूमस्य बङ्गानामानुविचारं ततोपचर्यं, तत्त्वापि देवाकरादिषु तदभावोऽस्य कुतश्चः। तथा हि भूतो भूतो रासमि हटे खूमी हटः, तदभावे च चहृष्टः, न च तद्वार्थः। तत्त्वातीय-खेद खूमस्य रासम् विज्ञा तति चक्षो भावात्, एवं चक्षयि चक्षो विज्ञाचेद जग्नितो खूः; क्लिन्तेजाहौ तत्त्वादीव एव रासभक्षयनुगमावेदयि विज्ञाचा-दिव भविष्यति, इति चवस्थं चहृष्टो भावं विवानन्तरं चत्पत्तात्। न च चक्षि

भावमात्रं नियामकं, तस्य रांसभादिषु अविशेषात् । तदनन्तरमेव इति च
अवधारण्यम् शङ्खायामभावात् । अवधारणेण तु शङ्खापणयने परस्परास्थ-
प्रसङ्गात् ।

Buddhist reply :—स्यादेतत् । यो यो धूमो हृष्टः स सर्वेषावत्
आद्रेष्यनसहितवक्ष्यनन्तरमेव, न पिण्डाचानन्तरं । स च कादाचित्कलया
निमित्तमपेक्षमाणी यदनन्तरमेव गच्छते तदेव अप्रतीतव्यभिचारं निमित्तं
करोति, न तु प्रतीतव्यभिचारं रासभादि । नापि सर्वेषाऽनुपत्तिभविष्यते ।
यदि न तत्त्वमित्तं कार्यात् विनाइपि वह्नि' क्वचित् धूमो न उप-
स्थिते । अथ असौ (पिण्डाचः) सर्वेषां वह्निसहितः तथा सति आद्रेष्यन-
वत् कथं वह्निरपि न कारणम् । कारणं चेत् कथं तमन्तरेण धूमभावशङ्खा ।
Now the phenomenon that is contingent (कादाचित्कल)
cannot be uncaused—अकारणस्य हि कार्यस्य निवं सर्वं
असत्त्वं वा स्यात्, अनपेक्षत्वात् न कादाचित्कल्यम् । And with the
limitation of a specific effect, there must be only
one specific cause, for an unrestricted plurality of
causes would amount to the denial of uniformity in
causality (i. e., of the *unconditional invariable*
antecedence)—

नापि अनेकं कारणं, अकारणत्वप्रसङ्गादेव । वङ्गमन्तरमेव भाव इति हि
धूमस्य वक्ष्यकार्यत्वम् । स चेत् अवह्निरपि अनन्तरं, न एवकारार्थः स्यात्,
इति न वह्नुः कार्यम् । एवम् अन्यस्यापि न कार्ये । न हि अन्यानन्तरमेव
भवति, वह्निरपि अनन्तर भावात्, तस्य वह्नितुको धूमः स्यात् । तथा च
कादाचित्कलव्याहतिः ।

Nyāya rejoinder :—सत्यम् । वद्यपि विना वह्नि' नोपक्षब्दी
धूमः, वद्यपि च पिण्डाचान्तरं नोपक्षभवते तिष्ठन्तुपद्धतेः, वद्यापि पिण्डाच-

कार्यं एव धूमः । तत्र तत्र वद्दुः कुरुश्चित् स्वचेतोः अपणिपतितः, रासभ इव, न धूमस्य जनकः । तेन तदभावेऽपि तत्त्वातीय एव कारणमेदजन्मा कदाचित् कादाचित्को धूमः स्थात् । इति अनिष्टिरिव शङ्खायाः । न च हृष्टसन्धवे नाहट' कल्पयितु' युक्तम् इति शब्दं भवाइवत्तुम् । अनुप-खम्बिलखण्डप्राप्तस्य अशक्यनिराकरणत्वात् (vide Nyáya Vindu) । न च अनुपलख्यन्तराणि अपि तत्त्विषेषे प्रभवन्ति । तत्त्वात् अनन्तरभेद इति अवधारण्याभावात् नैव कार्यकारणभावावधारणं युक्तम् । न च यदन्य-सहितानन्तरं उपस्थित्य स्त्र॒ तदन्यरहितात् स्थात् भवत् भिन्नतातीयं भवति । उत्तमं हि रामभसहितात् वद्दुः यादशी धूमः ताहश्च एव तदरहितात् वद्दु-रिति । तथादेवंविधा शङ्खापिशाची स्वनिवारकं तदुपत्तिनिश्चयमास्तुन्दती न शक्या निवारयितुम् ।

The Nyáya proceeds to point out that what is contingent need not necessarily be produced by a cause.. It is enough if there is natural connection with something else, a relation of antecedence and succession (or concomitance), without any element of productive efficiency or causation.

अपि चास्तु तदुपत्तिनिश्चयः तथाऽपि कथात् कारणमन्तरेण न कार्यं भवति । तथा च सति अनपेक्षतया कादाचित्कलविहितिः इति चेत् । अस्तु तर्हि स्वाक्षः स्वाभाविकतया अन्यानपेक्षः अव्यभिचारी गमकत्वाङ्गमः । स च यो वा स वा 'भवतु । ऊतं कार्यकारणभावावधारणासेव । यथा चेतत् तथा अत्र दर्शयिष्यामः । Váchaspati, Tátparyya-Tíka, Cháp. I, A'hnika 1, Sutra 5, व्यासियहोपायविचारः ।

The Nyáya analysis of the causal relation continued :—Co-effects :—In the enumeration of dif-

ferent varieties of irrelevant antecedents (अव्याप्तिहृत्), we have already noticed that co-effects of the same Cause are apt to be confounded as cause and effect. In some cases, the co effects may be simultaneous, e.g., the case of the ascending and the descending scale in a balance, which are co-effects of gravity (*vide Pá尔tha-sárathi Misra on Kumárlila, Sloka Vártika—सुन्यानमभीष्ममयोस्तु न मिथः काय्कारणलम्, उभयीरेककारणत्वात्—sloka 157, Súnya-Váda*). In other cases, the co-effects may be successive effects of the same cause, and here the risk is great of mistaking the antecedent co effect to be the cause of the succeeding co-effect ; e.g., the case of ants moving in a line to carry their eggs upward, which is observed before the summer rains ;—where the movement of ants and the rains are not cause and effect, but successive effects of the same cause, viz., the heat (चप्पा), which disturbs the elements, viz., the earth and the atmosphere (महाभूतचीम्); the ants being affected by this heat earlier than the atmospheric movements which bring the clouds and the rain.

(Uddyotakara, and Váchaspati—*न च पिपीलिकाश्च-सच्चरणं वर्द्धस्त कारणमनुपत्तव्यसामर्थ्यात्। असत्यपि तदिन् वर्द्धयीत् पसेः। वर्द्धमूलकारणस्य तु महाभूतचीमस्य पिपीलिकाश्चसच्चरणं पूर्वकाय्यम्। कथमानाः छत्रु पिपीलिकाः भौमीचप्पा छानि अच्छानि शूलिङ्गानि उपरिष्टात् नवमि—Tátparyya—Tíka II, 2, Sutra 37).*

Synchronousness of Cause and Effect.—This is resolved into a case of simultaneous co-effects of the same ultimate cause, e.g., the ascent of one scale and the descent of the other in the balance, which are not related as cause and effect, but are simultaneous effects of gravity. In other cases, the synchronousness is only apparent, the interval between the antecedent and the consequent being too small (सञ्चकाल) to be apprehended (योग्याभिनान) e.g., in the case of the needle piercing a hundred soft lotus petals laid one upon another, where the steps are really successive; or the illumination of the whole room by the light of a lamp, where the succession is unperceived owing to the inconceivable velocity of light (cf. Kumárilá, Sloka-Varttika,—हेतुहेतुमता सिवं योग्याभिनान्—यत् प्रदोपप्रमाद्युक्तं सञ्चकालोऽसि तत् तः। दुर्लभसु यथा वेधः पश्यत्वं तथा। Súnyaváda, Sloka 156-157.—I quote Mimánsá authorities, but the view is common to the Mimánsá and the Nyáya-Vaiseshika).

The time-relation in a chain of causes and effects :—A careful study of the time-relation in a chain of causes and effects is a peculiarity of the Vaiseshika system (and the later Nyáya). A moment (ultimate unit of time, Kshana, क्षण) is defined to be the time-interval between the completion of the sum of conditions and the appearance of the effect. The Vaiseshika conceives the unit to be determined by reference to the division

of one atom from another (विभागः शुत्पाद्य विभाग प्रागभावसम्बद्धकर्मावक्षित्रः कालः चणः—Sapta Padárthí, Sivá-ditya ;—i.e., the ultimate unit of time is the time during which motion exists in an atom prior to its division from another atom, in a case of division due to motion). The Sánkhya, we have already seen, determines this ultimate unit by reference to the motion of a Tanmátra.

The number of such units will determine the time-interval between a given set of physical conditions and a particular effect, for between a so-called sum of causes and a so-called sum of effects, there intervenes a series of atomic (or molecular) motions, with conjunctions and disjunctions which form the causal chain. However crude in the practical application, the fundamental idea is, in connection with the principle of work and energy (for which both the Sánkhya and the Nyáya-Vaiseshika furnish a rudimentary basis), immensely suggestive of a possible Time Calculus.

Plurality of Causes :—This will be discussed, when we consider the relation of Vyápti to the principle of Causality.

The Nyáya Ground of Inference—Vyápti व्यप्ति—Váchaspati) :—Inference, then in the Nyáya, depends on the ascertainment, not of the causal relation, nor of the relation of genus to species, but of a natural relation, between two phenomena, of invariable and unconditional concomitance

(उद्योतकारः स्त्रामाविकः सम्बन्धः वासिः— Uddyotakara and Váchaspati). Of the two phenomena so connected, one is called the Vyápya or Gamaka (the sign, mark or indicator), and the other Vyápaka or Gamyā (the thing signified, marked, or indicated). In the relation of fire and smoke, for example, smoke is the Vyápya or Gamaka (sign or mark); and fire, the Vyápaka or Gamyā the thing signified or marked). Now the relation of Vyápti between *A* and *B* may be either unequal or equipollent विषमव्याप्तिः or समव्याप्तिः). When *A* is the sign of *B*, but *B* is not the sign of *A*, the Vyápti is one-sided or unequal, and here a Vyápti is said to exist between *A* and *B*, but not between *B* and *A*. For example, smoke is a sign of fire, but fire is not universally a sign of smoke. When, therefore, the relation of Vyápti is an unequal one, as between smoke and fire, it is expressed in the proposition :—Wherever the Vyápya (sign or mark, e.g., smoke) exists, the Vyápaka (the thing signified or marked, e.g., fire) also exists. From this it follows by necessary implication (a sort of अर्थपत्ति) that whenever the Vyápaka (e.g., fire) is absent, the Vyápya (e.g., smoke) is also absent (आपकाभावे आप्याभावः). Again the Vyápti may be a mutual or equipollent one, i.e. *A* and *B* may be signs of each other, e.g. green-woed fire and smoke. Here each in turn is Vyápya and Vyápaka, and this is expressed in

the two propositions :—(1) Wherever there is smoke, there is green-wood fire, and (2) wherever there is green-wood fire, there is smoke. By necessary implication it follows—(1) where there is no green-wood fire, there is no smoke : (2) where there is no smoke, there is no green-wood fire. We have seen that a Vyápti exists between smoke and fire, for wherever there is smoke, there is fire. But we cannot say that a Vyápti exists between fire and smoke, for we cannot say that wherever there is a fire, there is smoke. The combustion of an iron-ball (अशीगीलक), for example, is a case of fire without smoke. But it would be correct to say that a Vyápti exists between green wood fire and smoke, as well as between smoke and green-wood fire. The question, therefore, is—What is the relation between fire and smoke ? The relation between fire and smoke is a conditional relation ; i.e., on condition that the fire is green-wood fire, it would be a sign of smoke. In other words, a Vyápti implies unconditional invariable concomitance, and the relation between fire and smoke is not therefore a Vyápti (natural unconditional concomitance), for fire requires a 'condition,' Upádhi. viz., green-wood, to be followed by smoke. Smoke, on the other hand, requires no 'condition' to indicate fire. For the purposes of Inference, therefore, relations between phenomena may

be considered as of two kinds :—(1) Contingent conditional relations, holding good on the fulfilment of a certain condition or Upádhi, and (2) Vyápti, or unconditional invariable relation, between a mark and that which it makes, a relation without any Upádhi or determining condition (उपाधिविभूतः सम्बन्धः). It is this latter kind of relation that serves as the ground of Inference. If we can ascertain that a Vyápti exists between *A* and *B*, then *A* is a sign of *B*, and an inference of the presence of *B* from the presence of *A*, and of the absence of *A* from the absence of *B*, would be warranted. The question, therefore, is—how to ascertain the relation of Vyápti between two phenomena.

Ascertainment of Vyápti according to the early Nyáya (व्यास्तिव्योपाय).—Briefly speaking, the observation of agreement in presence (अज्ञय) as well as agreement in absence (अव्यतीकर), between two phenomena, with the non-observation of the contrary (अभिकारादर्शनम्), is the foundation of our knowledge of Vyápti (दर्शनादर्शने—Váchaspati). This suggests a natural relation (सामान्यविकसम्बन्धः—Váchaspati) of invariable concomitance (नियतसाहचर्य—Váchaspati) between the phenomena, which is fortified by our non-observation (अदर्शन) of the contrary (अभिकार). But this does not establish the unconditionality of the concomitance (उपाधिविभूतसम्बन्धः), which is essential to a Vyápti. We have therefore to examine the cases carefully

to see if there is any determining condition (Upádhi—i. e. some hidden or undetected but really operative or indispensable accompaniment) which conditions the relation between the supposed sign or mark (Gamaka) and the supposed signate (thing signified, Gymja). Now let us consider what constitutes an Upádhi. It is a circumstance which always accompanies, and is always accompanied by, the supposed signate (the thing signified, Gamya), but does not invariably accompany the supposed sign or mark (Gamaka). If, therefore, in the set of positive instances where both the sign and the signate are present, nothing else is constantly present, there can be no Upádhi. Or, again, if in the set of negative instances where both the sign and the signate are absent, no other material circumstance is constantly absent, there is no Upádhi. This follows from the very definition of an Upádhi. It is impracticable to fulfil these requirements rigorously. Still, every one of the accompanying circumstances (of course the likely ones) may be taken successively, and it may be shown that the concomitance continues even when the suspected Upádhi (प्रतिलिपादि) is absent, and therefore it cannot be the Upádhi. And this is to be fortified by the observance of uniform and uninterrupted agreement in absence (Vyatireka) between the two concomitant phenomena. In this way, when we have disproved all

suspected Upádhis, we conclude by establishing the Vyápti. It is true that we may still go on doubting. But doubt has a certain limit for the ‘experimenter’ and the thinking person (परीष्कार, प्रेषावान्). When doubt overthrows the foundation of all rational practice (प्रामाणिकस्त्रीकर्यात्), or leads to a stoppage or arrest of all practical activity (खोकव्यवहार), it stands *ipso facto* condemned, and must be abandoned (व्याखातादपिराश्वा). Sríharsha and Udayana—व्याखात is mentioned by Vá-chaspati). Thus it is that Vyápti is ascertained. In this way, we observe innumerable instances of Vyápti. Now by means of repeated observations of this kind (भूयोदर्शन), we have established the principle of the Uniformity of Nature (समाद-प्रतिवन्ध), and also of Causality; and these two principles thus ascertained may be made use of in their turn as the basis of an argumentation or deduction (Tarka, U'ha, तर्क) to confirm a particular Vyápti in a particular case. Tarka or U'ha, then, is the verification and vindication of particular inductions by the application of the general principles of Uniformity of Nature and of Causality, principles which are themselves based on repeated observation (भूयोदर्शन) and the ascertainment of innumerable particular inductions of uniformity or causality (भूयोदर्शनवित्संख्यारुपितम् इत्यथमेव सामान्यिकसम्बन्धयात्—Váchaspati). Thus Tarka also helps in dispelling doubt (सन्देह). Sríharsha,

however, questions the validity of this verification,—cf. the well-known couplet ending तर्कः अद्वाविषः कुतः !

It will be seen that the process of disproving all suspected Upádhis (उपाधिशक्तानिराप), in the early Nyáya, answers exactly as a process to Mill's Method of Agreement. In fact, the disproof of a suspected Upádhi by pointing to instances of Agreement in absence (अन्वय) even in the absence of the Upádhi, fortified as this is by the instances of agreement in absence (अविरेक), virtually amounts to Mill's Joint Method of Agreement. But the fundamental difference is this :—Mill's Method of Agreement is formulated in view of the phenomena of causation (including co-effects, etc.) and, as usually enunciated, confessedly breaks down in dealing with cases of Uniformities of Co-existence unconnected with Causation ; the Nyáya Method based on the disproof of suspected Upádhis is a more daring and original attempt, and is far more comprehensive in scope, being applicable to all Uniformities of Co-existence and of Causation alike. And this the Nyáya successfully accomplished, by introducing the mark of unconditionality (उपाधिविभूता) into the relation of Vyápti (Concomitance), even as the same mark of unconditionality (अन्वयाधिविभूता) had been previously introduced into the definition of Causality (कार्यकारणमात्र). The difference between the early Nyáya and the Buddhist systems

may be briefly put thus :—The former relied on empirical induction based on uniform and uninterrupted agreement in Nature, and accordingly regarded the Method of Agreement as the fundamental Method of Scientific Induction, founding Inference on Vyápti to which they subordinated Causality in the doctrine of Method ; the latter assumed two *a priori* principles, viz., causality and identity of essence, deduced the canon of the Method of Difference by an indirect proof from the principle of causality, and made this Method the foundation of all scientific Induction of Causality, just as they based all natural classification of Genera and Species on their *a priori* principle of Identity of Essence.

[Text from the early Nyáya :—

Method of Agreement and the Joint Method without the device of the Upádhi :—

Cf. Jayanta on साहचर्य—तज्जिन् सत्येव भवने न विना अदनं ततः । अयमेवाविनाभावो नियमः सहचारिता । ‘तज्जिन् सत्येव’ ‘only this remaining throughout,’ while others change—implying the Method of Agreement. The set of positive instances, in which this antecedent alone is constant, must be supplemented by a set of negative instances (agreement in absence) :—अतिरिक्तजिव्यमन्तरैष प्रतिष्ठयहकालुपपचेः । नियमसाध्यं उच्यते यत् तज्जिन् सति भवनं ततो विना न भवनं इति भूयीदर्थंनम् । तत्र तज्जिन् उति भवनं इत्यन्यमात्-

परिच्छेदात् अर्थस्तीति नियमः स्तात् । हतो विना न भवने इत्यस्य
अर्थस्य अपरिच्छेदात् इति Jayanta, A'hnika II, व्यतिरेकव्याप्तिः-
नियमाबश्यकत्वम् ।

Doctrine of the Upádhi :—Unconditional con-comitance distinguished from conditional :—

यो वा स वा असु सम्बन्धः यस्य असौ स्वाभाविकी नियतः स एव गमकः,
गम्यस्य इतरः सम्बन्धोति युक्तते । तथा हि धूमादीना वह्नादिसम्बन्धः
स्वाभाविकः । ननु वह्नादीना धूमादिभिः । उपलब्धने ते हि विनापि
धूमादिभिः । यदातु आद्रेष्वनादिसम्बन्धम् अनुभवन्ति तदा धूमादिभिः सह
संवर्ध्यन्ते । तथात् वज्रादीनाम् आद्रेष्वनाद्युपाधिङ्गतः सम्बन्धो न स्वाभा-
विकः । ततो न नियतः । स्वाभाविकस्तु धूमादीना वह्नादिसम्बन्ध उपाधिः
अनुपलब्धमानात् क्वचित् व्यभिचारस्य अदर्शनात् अनुपलब्धमानस्यापि
कल्पनानुपर्यन्तेः । अतो नियतः सम्बन्धः अनुमानाङ्गम् ।

Concomitance sufficient without causal *nexus* :—

The Buddhist objects—In Nature, everything is connected with everything else. Hence if there were no *nexus* of causality between antecedent and consequent, everything might follow from everything else. The Nyáya replies—You admit uniformities (of co-existence, etc.) other than causal ;—so you confess that a natural fixed order can exist without causal *nexus*.....

An Upádhi, how established and how disproved :—

The Nyáya then proceeds to show how an Upádhi

is established, or how disproved by observation.—

तत्र वक्तः अनादेन्मनस्य विना धूमम् अयोगीलकादौ दर्शनात् आदेन्मनो-
पादिः अस्य धूमेन सम्बन्धः न तु स्वाभाविक इति निश्चयते । धूमविशेषस्य
तु विना वह्निम् अनुपत्तश्चात्, उपाधिमेदस्य च अदृश्यमानस्य कल्पनाथा
प्रमाणाभावात्, विशेषस्थृत्यपेक्षस्य च संशयस्य अनुपत्तभूत्ये अनुत-
पादात् उत्पादे च अतिप्रसङ्गात् प्रेक्षावत् प्रह्लयुच्छेदात्, स्वाभाविकः
सम्बन्धः अवधार्यते ।

General Method of Induction by exhaustion of the Upádhi, more comprehensive than Mill's Joint Method :—

For the definition of an Upádhi, vide Sríharsha and Udayana : अव्याप्तसाधनो यः साध्यसम्ब्यासिः उच्चते स उपाधिरिति । Hence to avoid an Upádhi (which is साध्यसम्ब्यासिः), the constant presence of anything relevant other than the sign and the signate in the positive instances (of agreement in presence, अनुपत्त), and the constant absence of any such thing in the negative instances (of agreement in absence, अव्यतिरैक) must be safe-guarded against. This amounts to Mill's Joint Method.

Suspicion of non-perceptible Upádhi—Limits of legitimate Doubt :—

न च अदृश्यमानोऽपि दर्शनान्वैतत्या साधकवाचकप्रमाणाभावेन
संदिक्ष्यमान उपाधिः स्वाभाविकत्वं प्रतिवक्षाति इति साम्यतम् । अव्यत-
िरैक्या भवितव्यं नियामकाभावादिति इतावकाशा खलु इथम्
प्रमाणाद्योदातिकमेव जडा पिण्डाचो लभ्यप्रसरा न कर्त्तिति नाकीति नेत्रं

कृचित् प्रवर्तेत् । सर्वत्रैव कर्त्तव्यित् कर्त्तव्यित् अनर्थस्य बहास्यदत्तात् ।
अनर्थबहायाश्च प्रेक्षावतो निरुत्यज्ञत्वात् । अन्तः चिन्धाद्रपालोपयोगीषु
अपि अरण्यादिदर्शनात् । तत्कात् प्रामाणिकलोकयावाम् अनुपालयता
यथादर्शनं बहुमीथम् !.....तत्त्वादुपाखिं प्रयत्नेन अन्वित्यनोऽनुपत्तभमात्रा
नाकौति अवगम्य खाभाविकत्वं सम्बन्धस्य लिपिनुभवः ।—

Tarka, U'ha,—Deductive verification of particular inductions by applying the two fundamental inductions of Uniformity of Nature, and Causality :—Doubt finally dispelled :—

Now innumerable particular uniformities of this kind (Vyáptis) are observed, and as a result of this repeated observation, a belief in the Uniformity of Nature (स्वभावप्रतिवृत्त), as well as in the principle of Causality (कार्यकारणभाव) is generated in the mind, a belief which has evidential value and validity. It is not intuition (ज्ञानसम्) but a mental pre-disposition based on uniform and uninterrupted experience (भूयोदर्शनगमितसंखारसंहितम् इन्द्रियमेव स्वाभाविकसम्बन्धयाहि,—अब भूयोदर्शनम् असाधारणम् इति प्रमाणान्तरं जातम्). Then armed with these new resources, the belief in uniformity and in causality as general principles, we proceed to fortify our particular inductions (Vyáptis), whether of uniformity of nature or of causality, by indirect deduction from these general principles :—We argue if, under these observed circumstances, *A* were not the mark of *B*, the principle of uniformity of nature would be violated,—Nature would not be uni-

form.—or, if under these observed circumstances *A* were not the cause of *B*, the principle of causality would be violated, the phenomenon *B* would be without a cause ;—and such indirect proof (तक्षण) gives us the overwhelming probability which we call practical certitude, and on which every reasonable man(every thinking and judging person) proceeds to act in due natural course.—
 स्वभावतस्य तिव्यादेततः स्वसाधेन, यदि साध्यतरिक्तं भवेयुः, स्वभावादेव प्रथमेरन्निति तर्कसहायः अनिरक्षसाध्यतरिक्तं सदैषा यत्र हट्टा; सच स्वसाध्यम् उपस्थापयन्त्वेव। Váchaspati I, 1, Sutra 5; cf. also, I, 1, Sutra 40—कहः कारणस्योपपत्त्या संभवेन जायते। कारणासम्बन्धे कार्यस्य असम्भात्।]

Instances of Vyápti (uniformity) not comprehended under Causality, or the relation of Genus and Species :—The Nyáya points out that the relations of cause and effect and of genus and species do not exhaust the grounds of Inference. There are cases of Inference based on Vyápti (*i. e.*, on invariable and unconditional concomitance) which come neither under Causality (तदृत्पत्ति) nor under Identity of Essence ,(तादात्मा). Váchaspati notes that to-day's sunrise and yesterday's sunrise, the rise of the moon and the tide in the ocean, the relative positions of the stellar constellations, are instances of Vyápti (invariable concomitance) between phenomena which are neither related as cause and effect, nor as genus and species. Jayanta adds the conjunction of sun-set with the appearance of the stars,

of ants moving in procession (with their eggs) with the approach of the rains,—of the rising of the constellation Agastya (Canopus) above the horizon with the drying up of rivers; of the spring tide with the full moon; and dismisses as sophistical and far-fetched the Buddhist attempt to explain all these cases by means of causality. We have seen that the Nyáya and the Mimásá reduce most of these conjunctions to cases of co-effects of the same cause, co-effects which may be either simultaneous or successive.

अपि च अद्यतन्त्रम् सवितुष्टदयस्य अस्तनेन सवितुष्टदयैन्, चन्द्रोदयस्य
च समानकालीन समुद्रहस्ता.....न कार्यकारणभावः तादाक्षं वा । अद्य
हटो अग्रभकभावः ।—Váchaspati, Tátparyya-tíká, I, 1,
Sútra 4;—Cf. also Jayanta, Nyáya Manjari—अन्येषामपि
द्वितीया भूम्बो जगति दर्शनात् । सूर्यास्तमयमालीक्ष वस्ते तारकीदयः ।
पूर्णचन्द्रोदयाहृदिरस्तुष्टिरवनम्भवते । उद्दितेनानुभोवने सरितः कुशयोगिनः ।
गुणत्पुरिमपथ्यन् विश्वामित्रमपेक्षयः । पिपोलिकाङ्गसवारचेष्टानु-
मितहृष्टयः । भवन्ति पर्याकाः पर्षकुटीरकरणोदयताः ।

Vyápti between Cause and Effect :—Relation of causality to Vyápti :—

On the Buddhist (and early Nyáya) view that one specific assemblage of 'effect' phenomena has one specific assemblage of causal conditions, there would be two aggregates, the sum of causal conditions (कारणसामग्री), and the sum of effects (कार्य-सामग्री). For example, fire requires green-wood to complete the sum of causal conditions to give rise to smoke with some particular marks (पूर्णिषेष,—

वृजपाञ्चतादिचर्चदिश्ट, Jayanta II ; compare Gangesa काण्डागुदप्रभवद्विभानय कटुकासुरभिपाञ्चरच्छवस्त्रात् ।— Chintámani, Anumana, Viruddha Siddhánta). Here, between an effect and a single condition (termed a cause) there is a relation of Vyápti. The effect is Vyápya or Gamaka (the sign or mark); the cause (or condition) is Vyápaka or Gamyā (the thing signified). In other words the presence of the effect indicates the presence of the causal condition, and the absence of the causal condition will by implication indicate the absence of the effect. Smoke of this particular kind is supposed to be an effect of which there is one and only one assemblage of causal conditions (fire and green-wood); hence where there is smoke, there is fire; and when there is no fire, there is no smoke.

Now introduce the complication of the plurality of causes:—Fire, for example, is the effect of several assemblages, e. g., (1) blowing on heated grass, (2) focussing rays through a lens on a combustible like paper or straw, (3) friction with the fire drill, etc. Here each assemblage is regarded as a sum of causes. But in this case there is no Vyápti between the effect ‘fire’ and any particular assemblage of causal conditions, say, of the lens or the fire drill. For the presence of fire does not indicate the presence of the lens or the fire drill assemblage, nor does the absence of either of the latter in particular, indicate the absence of fire.

Indeed in such a case, the effect 'fire' is not a mark or sign (Gamaka or Vyápya) of any one in particular of the different possible causal assemblages, though each of these particular assemblages of causal conditions is a mark or sign (Gamaka or Vyápya) of fire.

The plurality of causes requires a further consideration in the light of the definition of the causal relation. A cause is defined to be the unconditional invariable antecedent. From the unconditionality, it follows that the entire sum of conditions, and not one single condition, is, properly speaking, the cause. In view of the plurality of causes, an invariable antecedent must be taken to mean that any particular cause (i. e., assemblage of causal conditions) is invariably followed by the effect,—not that the effect is invariably preceded by any particular cause.

Popularly, a single condition, say the lens or the fire-drill, is said to be a cause of fire ; but, in view of the plurality of causes, this is apt to be misleading, as there is no Vyápti in this case : the lens or the fire-drill is no more a mark of fire than fire is a mark of the lens or the fire-drill.

The plurality of causes strains the definition of a cause, and undermines the relation of Vyápti between an effect and a cause. Any particular cause (causal aggregate) still indicates the effect, but not *vice versa*. The earlier Nyáya (down to

Váchaspati and Jayanta) obviated the plurality, as we have seen, by introducing distinctive marks in the effect such as would indicate a single specific cause (कार्यवैषयिक or कार्यमिद् indicating कारणवैषयिक or कारणमिद्). Some indeed went further and held that when the antecedent causal assemblages differ in kind, the effect phenomena, though apparently the same, do really differ specifically (or in kind)—कारणवैजातिकं कार्यवैजातिकम्। But the Nyáya discards this hypothesis; the fire is the same, though the possible causes (or causal aggregates) differ, e. g., the lens, the drill, etc. But the effect phenomenon to which we attend is not the only effect;—in the case of plurality of causes, we must carefully examine the accompaniments of the effect, i. e., the sum of effects, and the examination will shew some distinctive or specific circumstance or accompaniment which will enable us to definitely determine the particular assemblage of causal conditions that must have preceded in the case under examination. This is the device of the earlier Nyáya as well as of the Buddhists, as we have seen; but the later Nyáya doubts the practicability as well as the theoretical validity of such a step on an unrestricted assumption of the plurality of causes, and feels troubled by the circumstance that no effect for which more than one cause (or causal aggregate) can be assigned, can be regarded as a mark or sign (Gamaka or Vyāpya) of any one of

the causes in particular. Accordingly, some adherents of the later Nyáya advanced the proposition that when more than one causal aggregate can be supposed for any effect, the latter is a mark or sign (*Gamaka* or *Vyápya*), not of any one of the causal aggregates in particular, but of one or other of them ; and the absence, not of one such cause, but of each and every one of them, alone indicates the absence of the effect. A cause therefore should be defined to mean *one or other* of the possible alternative aggregates which, being given, the effect follows invariably and unconditionally. If we ask what is the defining mark (or quiddity) of the cause (कारणताव्युदेत्ता), we are told that it is *one-or otherness* (अव्यवस्था), and nothing else ; others cut the Gordian knot by assuming that the different possible causes of the same effect possess a common power or efficiency (अस्तिरिक्तशक्ति), or a common 'form' (जातिसौम्या), which accounts for the production of a common effect. The latter is therefore a sign or mark of this power (शक्ति), or this form (जातिसौम्य), which is manifested by each of the causal aggregates. This hypothesis (कल्पना), they hold, is simpler and more plausible than the hypothesis of specific differences latent in the apparently identical effect of a plurality of causes (कारणवैज्ञानात् कार्यं बोधम्).

(Cf. Dinakari on the Siddhanta Muktavali—किंचित्
वक्ति प्रति दृष्टकुरुत्वारं संशोगादीना दृष्टपुत्रकारसंबोधवादिष्वपेष

कारणतया व्यभिचारेण असम्भवात् अर्तारक्षम्भिर्विद्धिः । न च
दृष्टफुलकारयोः अरचिनिर्मन्त्रेयाः मणितरचिकिरणयोश्च सञ्चयस्त
जन्मतावच्छेदकं वर्णित्वादैजात्यवयं कल्पयिति न व्यभिचार इति वाच्यम् ।
तत्त्वमतावच्छेदकदैजात्यवयकाश्चनामपेत्य तत्त्वसञ्चालनां एकाशक्तिसत्त्वेन
कारणत्वकल्पनाया एव खधुत्वेन व्यायत्वात् इत्याहुः । तत्र ।... अन्यतमत्वेन
कारणतासम्भवात्.....परे तु दृष्टादिसम्बन्धकालीनवायुसंबोगादीनां एक-
अक्षितसत्त्वेन उत्तुतामादाय विनिगमनादिरहात् न वर्णित्वादैजात्याहुः ।
Sloka 2, cf. also, लृषार्द्धामस्यान्यतमत्वं कारणस्य विनिगमकम् ।

Cf. Udayana, Kusumánjali, Stavaka 1—कर्तुं न द्विः
दृष्टारचिमित्यभी भवद्वायुसंबोगादीयः । एकाशक्तिसत्त्वात्
इति चेत् न । यदि हि विजातीयेत् अपि एकातीयकार्यकारण-वृक्षः
समवेद्यात्, न कार्यात् कारणविशेषः लक्षित् अनुभवीयत । कारणव्याप्त्या च
न तत्त्वातीयस्यैव कार्यस्य व्याङ्गादिवसीयेत् ।....एतेन सुखातीयमिति-
निरक्षम् । अवझेरपि तद्वसीक्षणात् चूमीतपञ्चापत्तेः ।

The Scientific Methods already noticed, the Joint Method of Difference (the Panchakárani), and the Joint Method of Agreement (Vyáptigraha with Upádhisanká-nirasa and Tarka), are not the only methods of ascertaining causality or concomitance, or establishing a theory (हितान्तः); nor are these Methods always practicable. Very often, we reach the explanation of a fact (उपपत्ति) by means of a Hypothesis (कल्पना) properly tested and verified (निर्दोष). A legitimate Hypothesis must satisfy the following condition :—(1) the hypothesis must explain the facts (हट्टिति, or उपपत्ति; (2) the

hypothesis must not be in conflict with any observed facts or established generalisations (दृष्टिकौण्डली इति वृद्धं कल्पाते, न दृष्टिविधाताय—Jayanta, Nyāya-Manjari, A'hnika 1); (3) no unobserved agent must be assumed, where it is possible to explain the facts satisfactorily by observed agencies (यदि वृद्धमन्तरेण वृद्धं न सिद्धाति काममवृद्धं कल्पयताम्, अव्याप्तिपि तदुपपत्तो किं तदुपकल्पनेन, *ibid*); (4) when two rival hypotheses are in the field, a crucial fact or test (विनिगमक, *ratio sufficiens*) is necessary; the absence of such a test (विनिगमनाविरह) is fatal to the establishment of either, (5) of two rival hypotheses, the simpler, *i.e.*, that which assumes less, is to be preferred (*ceteris paribus*) (कल्पनालाभव व्यवस्था विशेषा); (6) of two rival hypotheses, that which is immediate or relevant to the subject-matter is to be preferred to that which is alien or remote (प्रथमोपस्थितत्व) ; (7) a hypothesis that satisfies the above conditions must be capable of *verification* (निर्णय) before it can be established as a theory (विज्ञान). The process of verification of a hypothesis consists in showing that it can be deduced as a corollary from (or is involved by implication in some more general proposition which is already well-established (cf. Vatsyayana's exposition and illustration of Verification, निर्णय—including both the Deductive Method and Colligation).

This doctrine of Scientific Method, in Hindu Logic, is only a subsidiary discipline, being com-

prehended under the wider conception of Methodology, which aims at the ascertainment of Truth whether scientific (Vijnana) or philosophical (Jnana) (जीवे वौक्तानम् खात् विज्ञानं विषयाःस्याः; Amara-Kosha);—the latter being the ulterior aim. In the investigation of any subject, Hindu Methodology adopts the following procedure: (1) the proposition (or enumeration) of the subject-matter (Uddesa), (2) the ascertainment of the essential characters or marks, by Perception, Inference, the Inductive Methods, etc.,—resulting in definitions (by अच्छ) or descriptions (by अपच्छ); and (3) Examination and Verification (परोक्षा and निर्वचन). Ordinarily the first step, Uddesa, is held to include not mere Enumeration of topics, but Classification or Division proper (विभागः उद्देश्यप्राप्तात् उद्देश्य एवासौ! सामाज्यसंज्ञया कोर्त्तुमुद्देशः प्रकारमिदसंज्ञया कोर्त्तु विभाग इति—Jayanta, Manjari); but a few recognise the latter as a separate procedure coming after Definition or Description. Any truth established by this three-fold (or four-fold) procedure is called a Siddhánta (an established theory). Now the various Pramána-s Proofs, *i.e.*, sources of valid knowledge) in Hindu Logic. *viz.*, Perception, Inference, Testimony, Mathematical Reasoning (अच्छ including Probability in one view) are only operations subsidiary to the ascertainment of Truth (परमनिर्वचन). And the Scientific Methods are merely ancillary to these Pramána-s themselves.

I have explained the principles of the Hindu doctrine of Scientific Method, avoiding the technicalities of Logic as far as possible ; and I cannot here enter upon the logical terminology or the logical apparatus and machinery, which would require a separate volume to themselves. For these, I would refer the reader to my paper on Hindu Logic,—as also for an account of the later Nyáya (न्याय), which, in spite of its arid dialectics, possesses a three-fold significance in the history of thought : (1) logical, in its conceptions of Avachchhedaka and Pratiyogi, being an attempt to introduce quantification on a connotative basis, in other words, to introduce quantitative notions of Universal and Particular, in both an affirmative and a negative aspect, into the Hindu theory of Inference and Proposition regarded connotatively as the establishment of relation among attributes or marks ; (2) scientific, in its investigation of the varieties of Vyápti and Upádhi, (and of व्याप्तिशिला) being an elaboration of Scientific Method, in the attempt to eliminate the irrelevant ; and (3) ontological and epistemological, in its classification and precise determinations of the various relations of Knowledge and Being, with even greater rigidity and minuteness than in Hegel's Logic of Being and Essence. I will conclude with a few observations on Applied Logic. i.e., the logic of the special sciences, which is such a

characteristic feature of Hindu scientific investigation. What is characteristic of the Hindu scientific mind is that without being content with the general concepts of Science and a general Methodology, it elaborated the fundamental categories and concepts of such of the special sciences as it cultivated with assiduity, and systematically adapted the general principles of Scientific Method to the requirements of the subject-matter in each case. The most signal example of applied logic (or Scientific Method) worked out with systematic carefulness is the Logic of Therapeutics in Charaka, a Logic which adapts the general concepts of cause, effect, energy, operation, etc., and the general methodology of science to the special problems presented in the study of disease, their causes, symptoms and remedies (*vide* Charaka, Vimánasthána, Chap IV,—also Sutra Sthána, —*vide* my Paper on Hindu Logic). Here I will give an illustration of Applied Methodology from the Science of Analytical and Descriptive Grammar. Patanjali, in the Mabábháshya, (Circa 150 B. C.) is very careful as regards Methodology. I take no note now of the philosophical presuppositions of his philology (*vide* my Paper on the Hindu Science of Language), but will confine myself to his presentation of the Applied Logic of Descriptive and Analytical Grammar. The sentence is the unit of speech, as every Hindu philologer contends, but the first business of Analytica

Grammar is to analyse the sentence into its significant parts and their coherent relations to one another. Assuming that articulate sounds are significant, the question is —how is the sentence, which is the unit of articulate speech, broken up into significant words and their mutual relations? Patañjali answers that this is done by an instinctive use (cf. Vāchaspati's भूतो दर्शनजनितसंस्कारम् इन्द्रियम्) of the Joint Method of Difference (combined Addition and Subtraction), fortified by the Joint Method of Agreement (अन्वय-अतिरेकी). Patañjali starts with a simple case. Take the two sentence-units :—Pathati (he reads) and Pachati (he cooks). Suppose you start with the assumption that these sounds are significant, and that *separate elements have separate meanings*. Then you hear Pathati, and, at the same time, a man reading is pointed at. Then the assemblage of sounds Pathati (i. e., Path+ati) stands for the assemblage—'one reads,' (i. e. the action reading +an individual agent). Similarly by finger-pointing or other indication, you find that the assemblage Pachati i. e., Pach+ati) stands for the assemblage 'one cook's (i. e. the action cooking +an individual agent, say, the same agent as before).

Now look at the grouping :—

Path+ati = reading + one agent.

Pach+ati = cooking + one agent.

From repeated observation of similar groupings, one is led to conclude that path is the invariable concomitant of the action 'reading', because the disappearance of the formar (the other element remaining) leads to the disappearance of the latter (a rough Method of Difference by subtraction—हीयते); that Pach is the invariable concomitant of the action 'cooking' because the introduction of Pach (with nothing else added) leads to the introduction of the action 'cooking,' (a rough Method of Difference by addition,—उपजायते); and that Ati, which is the only 'common antecedent' (अन्वयी). is the invariable concomitant of 'one agent' which is the only common 'consequent' (अन्वयो). In fact, the last should come first by the Method of Agreement, then the other two either by Residue, or by Joint Agreement in presence and absence (अनुव्यञ्जनरैकी). So far all is plain sailing, though only very simple and very rough applications of the Methods are given. But—and this is the point—throughout the argument, it is assumed that one sound is the concomitant of one idea, in other words, there is no plurality of causes to vitiate the application of the Method of Agreement in the above example. And now the objection is advanced that this basal assumption is untrue. The same sound is not the concomitant of the same idea. Different words (sounds) may have the same meaning, and the same word (sound) may have

different meanings. We cannot therefore by the Joint Method of Agreement (अन्वयव्यतिरेकी) determine the meanings of words, or the separate functions of roots (stems) and inflections,—at least not so simply as is pretended above. Patanjali states this difficulty in the way of applying the Scientific Methods to the problems presented by Analytical Grammar, a difficulty arising from the plurality of causes, but does not state the solution. The solution, however, depends on the Method of subtraction and addition (Patanjali's शोषणे and उपजायने). For it will be found by extensive observation that the number of meanings of which a word (sound) may be capable is limited. So also is the number of words (sounds) expressive of a given meaning. Hence, by the Method of Difference, etc., the causal relations of words and meanings may be determined. Patanjali thus established the doctrine of Prakriti and Pratyaya (roots and inflections), with their separate significance, which is of course a necessary postulate in the case of an inflectional language like Sanskrit. Isolating and Agglutinative languages offer less difficulty whereas the difficulties are in some respect enhanced in the case of languages with a polysynthetic or incorporating (incapsulating) morphological structure.

कथं पुनर्जायते चयं प्रकृत्यार्थः चयं प्रत्ययार्थं इति । अन्वयव्यतिरेका तस्मै कोइसी अन्वयी व्यतिरेकी वा । इह पञ्चतीत्युक्ते कस्ति शब्दः शब्दः

पटतीत्युक्ते कथित् शब्दो हीयते (पृ०),—कथित् उपजायते (पृ०),—
कथित् अन्वयो (चति) ;—चर्योऽपि कथित् हीयते (विज्ञितिः),—
कथित् उपजायते (पठिक्रिया),—कथित् अन्वयो (कर्त्तव्यं चेकलंच) ।
तेन मन्वाभिर्यः शब्दो हीयते, तस्य असौ अर्थः योऽर्थो हीयते । यः शब्द
उपजायते तस्य असौ अर्थः योऽर्थे उपजायते । यः शब्दोऽन्वयो तस्य असौ
अर्थः योऽर्थोऽन्वयो ।

विषम उपन्यासः—वहशो हि शब्दा एकार्थी भवति । तदयथा इन्द्रः
अकः पुरन्दरः । एकश्च शब्दो वहर्थः । तदयथा यज्ञाः पादा भावा इति ।
अथ किं न साध्योऽर्थवत्ता सिद्धा भवति । नापि द्रूमीऽर्थवत्ता ग
सिद्धतीति । वर्णिता हि अर्थवत्ता अन्वयव्यतिरेकाभ्यामेव । तत्र कुत
पतदर्थं प्रकल्पत्यर्थः अर्थं प्रत्ययार्थं इति । (Mahábhsáhya, 1—3, 9,)

Patanjali not only applies the Scientific Methods to the foundations of Grammatical Analysis, but also by their means establishes and elaborates the fundamental categories and concepts of Grammatical (and Philological) Science, e. g., the concepts of action (क्रिया), agent (कर्ता), instrumental cause (करण साधकतमस्), end (नित्य), origin (उत्तु) limit (अवधि) substance (द्रव्य), quality (गुण), and genus (जाति);—also of the fundamental relations (at the bottom of all thought and speech)—the relations of Time (कालिकसम्बन्ध), of space (दिग्देशसम्बन्ध), of causality (कार्यकारणभाव), of inherence (समवाय), of co-inherence (सामान्याधिकरण), of substance and attribute (विशेषणाधिकरणभाव), of the sign and the signate (संज्ञासंज्ञिभाव), of mutual dependence (इतरैतराश्रय) ;—an entire grammatical (and philological) apparatus, which will serve as a *point d'appui* for generations of philologists and grammarians to come.

ADDENDA.

(BY PRINCIPAL BRAJENDRANATH SEAL.)

*Empirical Recipes from Varahamihira (circa
550 A.D.) relating to Chemical Technology.*

A. Searing of hard rocks to enable them to be cut (or pulverised) (शिलादारण).

Sprinkle on the rock taken red-hot from the fire of Palasa and Tinduka wood (*Butea Frondosa* and *Diospyros Embryopteris*) :—(a) diluted milk, or (b) a solution of wood ashes (the ashes of the *Mokshaka* mixed with those of reeds), or (c) a decoction of (the fruit) of the jujube (*Zizyphus Jujuba*) kept standing for 7 nights in a mixture of whey, vinegar and spirits, in which *Kulattha* (*Dolichos Uniflorus* or *Biflorus*) has been steeped, or (d) a solution of the ashes of the Neema bark and leaves (*Azadirachta Indica*), the sesame pod, the resinous fruit of the *Diospyros Embryopteris*, and the Guduchi (*Tinospora Cordifolia*) with cow's urine. Repeat the process seven times (in the last case six times).

(Varahamihira, Vrihat-sanhita, Chap. 33,
Slokas 112-117).

B. Hardening of steel (शस्त्रपाण).

(1) Plunge the steel red-hot into a solution of plantain-ashes in whey, kept standing for 24 hours ; then sharpen on the lathe.

(2) Make a paste with the juice of the Arka (Calotropis Gigantea), the gelatine from the horn of the sheep, and the dung of the pigeon and the mouse ; apply it to the steel after rubbing the latter well with (sesame) oil. Plunge the steel, thus treated, into fire ; and when it is red-hot, sprinkle on it water, or the miik of the horse (or the camel or the goat), or ghee (clarified butter), or blood, or fat or bile. Then, sharpen on the lathe.

(Varáhamihira, खण्डगवच्छाम,
chap. 49, slokas 23-26.

C. Preparation of cements (for rocks, metals, etc.) (बहुलेप)—

Varáhamihira gives the following recipes among others. (1) First, prepare a levigated powder with lac, the resinous exudation of the Pinus Devadara, the Balsamodendron Mukal, the Feronia Elephantum, the kernel of the fruit of the *Ægle Marmelos* (the *bel*), the *Diospyros Embryopteris*, the Neem (*Azadirachta Indica*), the Mhow (*Bassia Latifolia*), the Indian madder (*Rubia Manjistha*), the *Phyllanthus Emblica*, and the resin of the Sala tree (*Shorea Robusta*), then make a decoction of this in 256 Palas of water reduced

by boiling to 32 Palas, and apply the decoction hot.

(2) The horns of cows, buffalos and goats, asses' hair, buffalo's skin, with *gavya* (cow's urine etc.), the Neem (*Azadirachta Indica*) and the *Feronia Elephantum*, similarly treated.

(3) A mixture of eight parts of lead, two of 'bell-metal' and one of brass, melted and poured hot (*Maya's cement*).

The first, it will be seen, has lac, gum and turpentine as principal ingredients, the second makes use of gelatine, and the third is a metallic cement.

D. Nourishment of Plants :—(from Varáhamihiria, Chap. 54, on वृक्षायुक्ते).

The most suitable ground to plant in is soft soil that has been sown with the *Sesamum Indicum*, and dug up or trodden over with the sesame in flower. Grafts should be smeared with cowdung. For transplanting, the plants should be smeared with ghee (clarified butter), sesame oil, the honey of the Kshudra variety of the bee, the oil of the *Usira* (*Andropogon Laniger* or *Andropogon Citrarum*), the *Vidanga* (*Embelia Ribes*), milk and cowdung. Trees should be planted at intervals of 20 or 16 cubits.

As a sort of general prophylactic, mud kneaded with ghee (clarified butter) and *Vidanga*, (*Embelia Ribes*) should be applied to the roots, after which

milk diluted with water should be poured. As a remedy against barrenness, a hot decoction should be made of Kulattha (Dolichos Uniflorus or Biflorus), Masha (Phaseolus Roxburghii), Mudga (Phaseolus Mungo), Tila (Sesamum Indicum), and Yava (barley); which, when cooled, should be poured round the roots.

To promote inflorescence and fructification, a mixture of one A'dhaka (64 palas) of sesame, two A'dhakas (128 palas) of the excreta of a goat or sheep, one Prastha (16 palas) of barley powder, one Tula (100 palas) of beef, thrown into one Drona (256 palas) of water, and standing over for seven nights, should be poured round the roots of the plant. The measures given are for one plant.

To ensure inflorescence, etc., the seed before being sown should be treated as follows:—The seeds should be taken up in the palm greased with ghee (clarified butter), and thrown into milk;—on the day following, the seeds should be taken out of the milk with greased fingers, and the mass separated into single seeds. This process is to be repeated on ten successive days. Then the seeds are to be carefully rubbed with cowdung, and afterwards steamed in a vessel containing the flesh of hogs or deer. Then the seeds are to be sown with the flesh, with the fat of hogs added, in a soil previously prepared by being sown with and dug up or trodden down.

To ensure the formation of Ballaris (*i.e.*, sprouting and the growth of luxuriant stems and foliage), the seeds should be properly soaked in an infusion of powdered paddy, *Masha* (bean), sesame and barley mixed with decomposing flesh, and then steamed with *Haridra* (turmeric). This process will succeed even with the *Tintidí* (*Tamarindus Indica*). For the *Kapittha* (*Feronia Elephantum*), the seeds should be soaked for about two minutes (lit. such length of time as it would take one to make a hundred rhythmic claps with the palms तालमण्ड in a decoction of eight roots (*A'sphota*, *A'malakí*, *Dhava*, *Vásika*, *Vetasa*, *Suryyavalli*, *Syáma* and *Atimukta*, *i.e.*, the Jasmine, the myrobalan, the *Grislea Tomentosa*, the *Justicia Ganderussa*, the *Calamus Rotang*, the *Gymandropsis Pentaphylla*, the *Echites Frutescens*, and the *Dalbergia Oujeinensis*) boiled in milk. The seeds should then be dried in the sun. This process should be repeated for thirty days. A circular hole should be dug in the ground, a cubit in diameter and two cubits deep, and this should be filled with the milky decoction. When the hole dries up, it should be burnt with fire, and then pasted over with ashes mixed with ghee and honey. Three inches of soil should now be thrown in, then the powder of bean, sesame and barley, then again three inches of soil. Finally, washings of fish should be sprinkled, and the mud

should be beaten and reduced to a thick consistency, then the seed previously prepared should be placed in the hole under three inches of soil, and fish-washings poured. This will lead to luxuriant ramification and foliage, which will excite wonder. The Agnipurána adds that the mango is specially benefited by cold fish-washings (मत्स्योदकेन शोत्रेण आभारा सेक इष्टते—इष्टायुर्वेद, Agnipurána). It will be seen that these elaborate recipes are empirical contrivances for supplying the requisite nitrogen compounds, phosphates and bacteria, these being potentially contained in the mixtures and infusions prescribed.

SANSKRIT TEXTS.

Extracts from RASARATNAKARA.

नागर्जुन-विरचितात्

रसरत्नाकरादुद्भूताः श्लोकाः ।

अथ महारसशोधनं व्याख्यास्यामः ।

किमत्र चित्रं यदि राजवत्तेकं

शिरोषपुष्पाग्ररसेन भावितम् ।

सितं सुवण्णं तरुणार्कसन्निभं

करोति गुञ्जाशतमेकगुञ्जया ॥ १ ॥

राजावत्तशोधनम् ।

किमत्र चित्रं यादि पीतगन्धकः

पलाशनिर्यासरसेन शोधितः ।

आरस्यकैरुत्पलकैस्तु पाचितः

करोति तारं चिपुटेन काञ्चनम् ॥ २ ॥

गन्धकगुडिः ।

किमद्र चिदं रसको रसेन

* * * * |

क्रमेण छात्वाऽबृधरेण रस्तिः

करोति शुखं त्रिपुटेन काञ्चनम् ॥ ३ ॥ *

रसकशोधनम् ।

किमद्र चिदं दरदः सुभावितः

पयेनां मेष्टा बहुशोऽन्नवर्गे ।

सिं सुवर्णं बहुघर्मभावितं

करोति साक्षाहरकुङ्घमप्रभम् ॥ ४ ॥

दरदश्चिः ।

कुलत्यकोद्रवक्षाये नरमूत्रेण पाचयेत् ।

वेतसाद्यन्नवर्गेण दत्त्वा ज्ञारं पुटचयम् ॥ ५

किमद्र चिदं कदलीरसेन

सुपाचितं सूरणकन्दसंस्थम् ।

* Agrees nearly with Rasárnavā ; cf. Vol. I. Sans. Texts, p. 13.

† पर्वता is the correct form.

वातारितैसेन दृतेन ताप्यं
पुटेन दग्धं वरशुद्धिमेति ॥ ६ ॥
मात्रिकशोधनम् ।

हिगुणा विमला पथा रक्षातोयेन संयुता ।
स्लवणैर्वर्वा* दुग्धेन ताम्रपदाणि लेपयेत् ॥ ८ ॥
अग्नौ सम्प्य निर्गुण्डौरससिक्तानि समधा ।
मासान् वसुरसेनैव शुखशुद्धिर्भविष्यति ॥ १० ॥

परतः सर्व्वलोक्षशोधनम् ।
अस्त्रवेतसधान्याम्बेष्टीतोयेन शुद्धति ॥ ११ ॥
विमलशुद्धिः ।

चपलाद्या धातवः सर्वे जन्मोररसभाविताः ।
शोधितास्त्रिदिनं पञ्चमृत्तिकाभस्मलावणैः ।
संयुताः संशोधयन्ति पुटपाकेन काञ्छनम् ॥ १२ ॥
हेमशोधनम् ।

नागेन द्वारराजेन धापितं शुद्धिसूच्छति† ।

* The text reads वक्ष, which is incorrect.

† This verse also occurs in Rasarnava.

तारं विवारनिक्षिसं पिशाचीतैलमध्यगम् ॥१३॥

ताइशुद्धिः ।

अहो तु चिक्रं पृथिवीभवेन
सारेण मेषीपयसा दृतेन ।
तैलेन शुद्धं द्रूषोड़शांशं
भवेत् शुद्धं शशिशृङ्गसन्धिभम् ॥१४॥

मोक्षमारोटपालाश-क्षारगोमूलभावितम् ।
वज्रकन्दशिखाकल्क-फलमूलसमन्वितम् ॥२३॥

तल्कल्कं कण्ठकं साक्षाच्छूर्णं वै क्रान्तसम्भवम् ।
सारघेण* समायुक्तं मेषशृङ्गोद्रवान्वितम् ॥२४॥

पिण्डितं सूक्ष्मुषाखं धामितच्च हठानिना ।
तत्रैव पतते सत्त्वं वै क्रान्तस्य न संशयः ॥२५॥

वै क्रान्तमत्त्वम् ।

क्षीद्रं गन्धर्वतैलं सष्टुतमभिनवं
गो रसं सूदकच्च

* These couplets also occur in R. R. S., with this difference that in the latter नवसार has been substituted for सारख.

भूयो वातारितैऽसं कदलिरसयुतं
 भावितं कान्तितम् ।
 मूषां क्षत्वाम्निवर्णामृषाकरनिभां
 प्रक्षिपेत्याच्चिकेन्द्रं
 सत्त्वं नागेन्द्रतुत्यं पतति च सहसा
 सूर्यवैश्वानराभम् ॥ २५ ॥ *

महाहृषाक्षीराभ्यां स्त्रीस्तन्येन सुभावितम् ।
 मूषायामन्निवर्णायां द्रवेत्ताप्यं न संशयः ॥ २६ ॥
 कहुष्टटक्षणाभ्यास्त ताप्यं स्त्रीस्तन्यमर्हितम् ।
 पश्चात्सत्यं निपतति सत्यं मूषा तु अन्निवत् ॥ २७ ॥
 काञ्जिकं बहुशस्त्रियं ताप्यचूर्णं कटुत्रिकम् ।
 क्षत्वाम्बुमधुभ्यां पक्षां वज्रपायसभावितम् ॥ २८ ॥
 गृहधूमं ष्टुतं क्षीद्रं संयुतं पुनरेव च ।
 धामितं मूकमूषायां शशिशुखनिभं भवेत् ॥ २९ ॥
 कदलौरसशतभावितं ष्टुतमध्वेरण्डतैलपरिपक्षाम् ।
 ताप्यं सुच्छति सत्यं रसकच्छैव विसर्पते ॥ ३० ॥
 माच्चिकसत्यपातनविधिः ।

* Cf. Rasárnava, Vide Sans. Texts, Vol. I., p. 12

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चारखेइव धात्वाच्चे रसकं भावितं यहु ।  
 उर्धा दात्ता तथा पथा भूलता भूमसंयुतम् ॥ १ ॥  
 मूकमूषपागतं धातं टङ्गेन समन्वितम् ।  
 सत्त्वं कुटिलसङ्घाशं पतते नात्र संशयः ॥ २ ॥ \*

रसकसत्त्वम् ।

विमलं शिथौरेन काक्षीकासौसटङ्गेः ।  
 वज्रकन्दसमायुक्तं भावितं कदलौरसैः ॥ ३ ॥  
 माक्षीकाक्षारसंयुक्तं धामितं मूकमूषके ।  
 सत्त्वं चन्द्रार्कसङ्घाशं पतते नात्र संशयः ॥ ४ ॥ †

विमलसत्त्वम् ।

दरदं पातनायन्ने पातितच जलाशयी ।  
 सत्त्वं द्रूतकसङ्घाशं जायते नात्र संशयः ॥ ५ ॥

दरदसत्त्वम्

गन्धकच प्रभावेण सत्त्वभूयं सुभावतः ।

\* Cf. Rasárnava, Benares MS. V. 37—38.

† Cf. Sans. Texts, Vol. I. p. 12. R. R. S. Bk. ii,  
103—104.

ततः स्यातं महासर्वं रसेन्द्रस्य समं ततः ॥ ३८ ॥

अभ्रकादिसच्चपातनविधिः ।

\* \* \* \*

एक एव महाद्रावौ पार्वतीनाथ सञ्चवः ।

किं पुनस्त्रिभिः संयुक्तो वेतसाम्लाङ्गकाञ्जिकैः ॥ ५० ॥

मुष्काफलानि सप्ताहं वेतसाम्लेन भावयेत् ।

पुटपाके ततशृण्ये द्रवते सलिलं यथा ।

कुबते योगराजोयं रद्धानां द्रावणे परम् ॥ ५१ ॥

अभ्रकादिद्रुतपातनविधिः ।

तालेन वज्रं दरदेद तौर्णं

नागेन हेमं शिलया च नागम् ।

गम्भाइमना चैव निहन्ति शुखं

तारच माद्योकरसेन इन्द्रात् ॥ ५२ ॥

\* \* \* \*

शुखम् अजाहौरसुगम्भकेन

तारं चुहीक्षीरसुमाञ्जिकेण ।

यद्यथा धातोर्विहितच युक्तं

निहतवातं कथितच तौर्णैः ॥ ५४ ॥

नृतानि लोहानि रसौभवन्ति  
रसेन युक्त्यामयनाशनानि ।  
अभ्यासयुक्तश्च पक्षितादिनाशं  
कुर्वन्ति तेषाच्च जराविनाशम् ॥ ५१ ॥

इति नागार्जुनविरचिते रसरात्राकरे वज्रमारण-  
सत्प्रपातन-अभ्यकादिद्रावण-वज्रलोह-  
मारणाधिकारो नाम हितीयः ।

अथातो रसबन्धाधिकारं व्याख्यास्यामः ।

जग्मीरजेन नवसारघ्ननाभ्यवगैः  
क्षाराणि पञ्च लवणानि कटुद्रव्यश्च ।  
शिंथूदकं सुरभिसूरणकन्द एभिस्-  
संमर्दितो रसनृपस्वरतेष्टलोहान् ॥ १ ॥

चारणजारणविधिः ।

प्रज्ञापारमिता निशीथममये खप्ते प्रसादौक्षतं  
नाशा तौख्यमुखं रसेन्द्रममलं नागार्जुनप्रोदितम् ॥ ४ ॥

रसं हेमसमं मर्द्यै पौठिकागिरिगन्धकम् ।  
 हिपदोरजनीरच्छां मर्दयेत् टङ्गणाम्बिताम् ॥३० ।  
 नष्टपिष्टच्छ सुज्ञाच्छ अन्धमूर्च्छा निधापयेत् ।  
 तुषाज्ञधुपुटं दत्त्वा यावङ्गमत्वमागतः ॥३१॥  
 भक्षणाक्षाधकेन्द्रसु दिव्यदेहमवाप्नुयात् ॥३२॥

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गर्भयन्त्रं प्रवस्थामि पौठिकाभस्थकारकम् ।  
 चतुरंगुलदोर्बेण विस्तारेण च वशङ्गुलाम् ॥६२॥  
 मूषां तु मृद्ययीं क्षत्वा सुट्ठां वर्त्त्लां बुधः ।  
 विश्वभागन्तु लोहस्य भागमेकं तु गुमुलोः । ६३॥  
 सुश्वस्त्वा प्रेपयित्वा तु तोयं दत्त्वा पुनः पुनः ।  
 मूषालेपं दृढं बङ्गा लोणार्द्धमृत्तिका बुधः ॥६४॥  
 कषें तुषाम्निना भूमौ मृदुस्तेदेन स्वेदयेत् ॥६५॥  
 सूतकस्य पलं गृह्णां तुर्थ्यांशं साक्षकं विषम् ।  
 तक्षमं गन्धकं शुखं चूर्णं क्षत्वा विनिश्चिपेत् ॥६६॥  
 क्षत्वा कञ्जलिकामादौ पलं दत्त्वा च गन्धकम् ।  
 छृतपक्षच्छ तच्छृण्ँ पचेदायसभाजने ॥६७॥

\* Cf. Rasarnava. Vide Sans. Texts, Vol. I p. 4.

यावहवत्वमायाति तत्प्रथात् तं विनिष्ठियेत् ।  
पुटे वा कदलौपवे सिंहं पर्यटकारसम् ॥८६॥  
द्वितीयपर्यटोरसः ।

### प्रणिपत्य सर्वनुषान्

(सद्गोधान्) सकलदोषनिर्मुक्तान् ।  
वस्ते सर्वचिताद्य  
कदापुटं सर्वसिद्धिकरम् ॥  
श्रीगैलपव्वंतस्यायौ सिंहो नागार्जुनो महान् ।  
सव्वसत्स्वोपकारौ च सर्वभाव्यसमन्वितः ॥  
प्रार्थितो ददते शोऽन्नं यज्ञं पञ्चति याहम् ।  
दृढा त्वागच्छ भोगच्छ सूतकस्य प्रसादतः ।  
सर्वसत्स्वामयावेद्धी सरसेन तथैव च ॥  
तेषां मध्ये प्रधानच्छ रद्धघोषः प्रचारकः ।  
छताच्छलिपुटो भूत्वा नागार्जुनपुरः स्थितः ।  
पृच्छते रसकर्माणि विद्यादानं ददस्व मे ॥

श्रीनागार्जुन उवाच—

साधु साधु महाप्राज्ञ तुष्टोऽहं भक्तवत्सलः ।  
कथयामि न सन्देहस्तस्या परिपृच्छताम् ॥

वलीपस्तिनाशक् तथा कालस्य धंसनम् ।  
यथा सोहे तथा देहे क्षमते नाच संशयः ॥

\* \* \* \*

सत्सानां भोजनार्थाय साधिता वटयक्षिणी ।  
द्वादशानि च वर्षाणि महाक्लेशः कृतो मया ॥  
तत्कालदृष्टद्रव्याणां दिव्या वाणी मया चुता ।  
अदृष्टप्रार्थिता पश्चादृष्टा त्वं भव साम्राज्यम् ॥

श्रीवटयक्षिण्युवाच—

साधु साधु महासिद्ध \* \* \*

किंचिप्रार्थय मे सिद्ध तत्सर्वं प्रददाम्यहम् ॥

श्रीनागार्जुन उवाच—

यदि तुष्टासि मे देवि सर्वदा भक्तिवक्त्वे ।

दुर्लभं चिषु लोकेषु रसवन्धं ददस्मि ॥

शालिवाहन उवाच—

सुवर्णरक्षभाण्डारं कुमारी मदसुन्दरी ।

निवेदितो मयाक्षा मे आदेशो देवि दीयताम् ॥

साधु साधु महाप्राञ्छ ममादेशप्रपालक ।

साध्यामि न सन्देहो युग्मतत्वेन साधकम् ॥

पुनरन्वं प्रवच्छामि मारुष्येन यथा ज्ञातम् ।  
 रसोपरसयोगेन सिद्धं सूतं सुसाधितम् ॥  
 विषशुख्यायनं नागं यज्ञार्थकाच्छनं ज्ञातम् ।

\* \* \* \*

शास्त्रं वशिष्ठमारुष्यं गुरुपाश्चेऽयथा ज्ञुतम् ।  
 तदहं सम्ब्रवच्छामि साधनस्त्रं यथाविधि ॥  
 सहायशोभनाः प्राज्ञा निरालच्चा दृढ़ब्रताः ।  
 कुलौनाः पापहीनास्त्रं साधयन्ति जितेन्द्रियाः ॥  
 कोष्ठिका वक्रनालच्चं गोमयं सारमिन्धनम् ।  
 धमनं लोहपवाणि औषधं काञ्जिकं विष्टम् ॥  
 कन्दराणि विचित्राणि \* \* \*

सर्वमेलयनं ज्ञात्वा ततः कर्म्म समारभेत् ॥

रत्नघोष उवाच—

साधयित्वा प्रयत्नेन कोटिवेद्धौ महारसः ।  
 शरोरेण विनेतेन सर्वं भवति निष्फलम् ॥

नागार्चुन उवाच—

कथयामि न सन्देहः साकार्षेन यथा ज्ञातम् ॥  
 आदृत्यच्च घनत्वस्त्रं चापर्शं गुरुतेजसः ।

यस्यैतानि न हृश्मते तं विद्याहुरसूतकम् ॥  
 नानावर्णं भवेत्सूतं विडाय बनचापलम् ।  
 लक्षणं हृश्मते यस्य मूर्च्छितं तं वदति हि ॥  
 गुरुत्वमरुणत्वं वा तेजो भास्करसचिभम् ।  
 अग्निमध्ये यदा तिष्ठेत् खोटब्ल्लय लक्षणम् ॥\*

अथातो रसेन्द्रमङ्गलानि यन्त्रविधिः ।

शिलायन्त्रं, पाषाणयन्त्रं, भूधरयन्त्रं, वंशयन्त्रं,  
 नलिकायन्त्रं, गजदम्तयन्त्रं, दोलायन्त्रं, अधःपातन-  
 यन्त्रं, भुवःपातनयन्त्रं, पातनयन्त्रं, नियामकयन्त्रं,  
 गमन(?)यन्त्रं, तुलायन्त्रं, काञ्छिपयन्त्रं, चाकौयन्त्रं,  
 वालुकायन्त्रं, अग्निसोमयन्त्रं, गन्धकत्राहिकयन्त्रं,  
 मूषायन्त्रं, हण्डिकायन्त्रं, कन(?)भाजनयन्त्रं घोणा-  
 यन्त्रं, गुडाभकयन्त्रं, नारायणयन्त्रं, जालिकायन्त्रं,  
 चारणयन्त्रम् ।

अथ प्रवर्णे सुगुरुपदेशान्  
 यः पाटलास्थस्य रसस्य छृष्टः ।

\* Cf. Rasárnava. Vide Sans. Text, Vol. I. pp. 17—18.

यस्य प्रभावात् स्थिरमेहः  
 व्यरादिकुषामयनिष्ठः स्वात् ॥  
 निष्ठिष्व स्वेषे विपुराम्लकस्य  
 बौजं दिशुद्वार्द्धपलप्रमाणम् ।  
 काथेन तस्य विपुरोद्धवेन  
 समर्दयेत् विदिनानि यावत् ॥  
 कन्धारसेन विदिनं ततस्य  
 सप्तार्चिषा चाय दिनतयस्य ।  
 चूर्णस्त्रिकाया रजनीरजेन\*  
 सम्भदितं तम् उष्टतोयधौतम् ॥  
 जौषि प्रमाणान्यथ सप्तमस्य  
 सम्यातयेत् पातनयन्नयोगात् ।  
 सम्यातितो निर्मलतासुपैति  
 सर्वप्रयोज्योऽपि हितं प्रशस्तम् ॥  
 पलं समादाय रसस्य तस्य  
 शुल्खस्य शुहस्य च कर्षमेकम् ।

\* The text seems to be incorrect.

द्वाष्टपिष्ठो विधिवस्तयोर्  
 गन्धारमचूर्णं हिगुणस्तदेयम् ॥  
 छ्रतप्रयोगेण विपाण्य पवान्-  
 निक्षिप्य खण्डे परिमद्दितस्त ।  
 निष्कस्त मात्रां त्वमृतस्त दस्ता  
 गुणाप्रमाणा गुटिका च कार्या ॥  
 श्रीलोकनाथस्त विभोः प्रसादात्  
 आतं मया पोटलिकाविधानम् ॥  
 \*        \*        \*        \*  
 इति रसेन्द्रमङ्गलं समाप्तम् ।

# Extracts from RASAHRIDAYA.

भगवद्गोविन्दपादविरचितात्

रसहृदयादुच्चताः श्लोकाः ।

A = MS. from Nepal.

B = MS. from India Office Library, with a commentary, named "Bálánvayabodhiká."

C = MS. from Benares.

हितौयपटलादुच्चताः श्लोकाः ।

[टीका—मूर्च्छितरसस्य उत्थापनसंस्कारमाह—]

अमुगा विरेचने हि सुविशुद्धो नागवङ्गपरिमुक्तः ।

स्त्रः<sup>1</sup> पातनयन्ते समुख्यितः<sup>2</sup> काञ्जिके' क्षायात्<sup>3</sup> ॥

[टीका—अथ मूर्च्छितरसस्य पञ्चमीहृष्टपातनसंस्कारं  
स्यष्टयमाह—]

(1) A reads पात्व, which makes the sentence incomplete and the metre defective.

(2) A reads युविष्ट, which is a tautology as well as a grammatical error.

(3) काञ्जिके क्षायात् is the variant in B. This is a defective metre.

कृत्वा तु शुल्पिष्ठै<sup>१</sup> निपात्यते नागवङ्गयहातः<sup>२</sup> ।  
 तस्मिन् दोषान् मङ्गा<sup>३</sup> निपतति शुद्धस्थात् सूतः<sup>४</sup> ॥  
 अष्टाङ्गुलविस्तारं<sup>५</sup> देवर्णं<sup>६</sup> दशाङ्गुलं त्वधोभाष्टम् ।  
 कण्ठादधः समुच्छितचतुरङ्गुलाङ्गलाधारम्<sup>७</sup> ॥  
 अन्तःप्रविष्टतत्त्वाष्ट<sup>८</sup> वदनजलमननिजम् खप्रान्ता<sup>९</sup> ।  
 उपरिष्टाच्चिपिटपटौ<sup>१०</sup> देयोदरषोङ्गशाङ्गुलविशाला ॥

- (1) A reads सुल्पिष्ठम्.
- (2) निपात्यते नागवङ्ग सदोष is the reading in A, which is incorrect as well as defective metre.
- (3) A reads सुल्प दाष्टात्यङ्गा.
- (4) A reads शुद्ध, which is a tautology as well as a grammatical error.
- (5) B reads अष्टाङ्गुलव विकीर्णे, which destroys the metre.
- (6) B reads देवर्णं तु, wherein तु is redundant.
- (7) B reads सम तत्त्वाष्टुलं तत्त्वालगारा, which mars the metre.
- (8) A reads अन्तःप्रविष्टतत्त्वाष्टं, which is a defective metre.
- (9) B reads प्रान्तः, which is grammatically incorrect.
- (10) A has उपरिष्टाच्चिपिटपटित, which is senseless.

तस्मिन्दधीर्जभाष्टे<sup>1</sup> निपातितः सकलदोषनिर्मुक्तः<sup>2</sup> ।  
 सुतरां भवति रसेन्द्रो जीर्णशासोऽपि पात्वोऽसौ<sup>3</sup> ॥  
 छत्वाय<sup>4</sup> नष्टपिण्डिं विफलाद्यिखिश्चिप्राजिकापटुभिः ।  
 संलेघ्य चोर्जुभाष्टे दीप्तैरुपलैरधः पात्वः<sup>5</sup> ॥  
 अथवा दीपकयन्ते<sup>6</sup> निपातितः सकलदोषनिर्मुक्तः ॥  
 कच्छुप्रयन्नामगंत<sup>7</sup> अच्छयपीठस्यदीपिकासंखः ।  
 यस्मिन्निपतति सृतः प्रोक्तः<sup>8</sup> तदौपिकायन्नम् ॥

- (1) A reads तस्मिन् दृंजभाष्टे, which is incorrect.
- (2) निपातितसकलनिर्मुक्तः, an incomplete variant in A.
- (3) A has an incorrect reading—यात्तजीर्णपपात्वासौ.
- (4) This verse and the next two are not found in B.
- (5) A reads रपरेष्वःशासा, which has no sense.
- (6) A has दीपनयन्ते.
- (7) A reads कच्छपयन्ते अनगंत, which is grammatically incorrect.
- (8) The word तत् is not found in A, thus making the metre defective.

सप्तमः पट्टाः ।

[टोका—अथ विड़विधानमारभते—]

यासं न मुच्छति न वाच्छति तच्च भूयः  
 कांच्छिद्गुणान्<sup>1</sup> भजति<sup>2</sup> नित्यमनुक्तमावात्<sup>3</sup> ।  
 यज्ञीर्यते प्रचुरकेवलवक्ष्योगात्  
 तस्माद्विद्वैर्मुनिविष्टः सह<sup>4</sup> जारणा स्यात् ॥

[टोका—विड़विधानमाह—]

सौवर्णलकटुकव्यकाङ्गो<sup>5</sup> काशीसगम्य कैष विड़ैः ।  
 शिशो रसशतभाव्यैस्ताम्बदलान्वपि हि जारयति<sup>6</sup> ।

[टोका—विड़ान्तरमाह—]

- (1) A reads कांच्छिद्गुणान्, which is incorrect.
- (2) B reads भजति.
- (3) मुक्तविमुक्तमावात् is the variant in A,
- (4) A reads मुनियतेरिसु, which seems to be incorrect.  
 मुनिविष्टः means by seven विष्ट, mentioned below.
- (5) A reads कांजि, which is incorrect.
- (6) A has विष्टरसशतभावितम् । नस्य दग्धान्वपि हि जारयति,  
 which is incorrect as well as defective in metre.

सर्वाङ्गदध्यमूलकप्रतिगतितं सुरभिमूलेण<sup>1</sup> ।  
 शतभाष्यं बलिवसया<sup>2</sup> तत्त्वयतो जार्यते हेम ॥

[टीका—अथ चारहृष्टगुल्मीषधौराह—]  
 कदलीपलाशतिल<sup>3</sup>निद्धूलकनकसुरदालिवासुकैरण्डाः ।  
 वर्षाभूष्ममोज्जकसहिताः चारा यथालाभम् ॥

[टीका—चारविधानमाह—]  
 आनीय चारहृष्टान् कुसुमफलशिफा-  
 त्वक्पलाशैरपेतान्<sup>4</sup>  
 छत्वादः खरुष्मस्तान्<sup>5</sup> विपुलतरशिला-  
 पिष्ठपादातिशुष्कान्<sup>6</sup> ।

(1) सर्वाङ्ग दध्यमूलकं रसप्रतिगतितसुरभिमूलेण, a variant in A, which has no metre at all.

(2) A reads शतभावितरसवसया, which has no sense.

(3) तिल is not found in B.

(4) A reads माञ्जीक, which seems to be incorrect.

(5) कुसुमपलाशवापचकैरपेतान् is an incorrect text in A.

(6) A reads छत्वा तत्त्वांडस्तान्, which is incorrect.

(7) A has विपुलतरशिलापृष्ठमातिशुष्कान्.

दन्धं काञ्जेसिकानां करिसुरभिह्या-  
ओभिरामाव्य वस्ते:<sup>1</sup>  
भस्म त्वक्ता असं तत्<sup>2</sup> स्तुशिष्विनि पचेत्  
इंसपाकेन भूयः<sup>3</sup> ॥

[टीका—चारजलपाकलक्षणमाह—]

तच्छ्रव्यमार्च हि सवास्यदुदुदान्  
यदा विधत्ते<sup>4</sup> चर्चमङ्गरान् वद्धन् ।  
तदा चिपेत् चूर्चवत्<sup>5</sup> हिङ्गम्यकं  
चारचयं सज्जवक्षानि भूखुगम्<sup>6</sup> ॥

- (1) A reads करिसुरभिह्यीङ्गाजकानां च मूचे.
- (2) A reads तं. which is incorrect.
- (3) A reads वाचत्.
- (4) A reads erroneously असा वद्दते.
- (5) A reads चिपेत् चूर्चवत्. B reads चिपेत् चूर्चवत्. Both the readings are incorrect.
- (6) A has चारवितयं पटुचावर्च भूमिखण्गं, which mars the metre.

द्रव्याणि संमिश्र निष्ठत्य भूतले  
 व्यवस्थितान्धस्त्रिकटोरिकापुटे<sup>1</sup> ।  
 संख्यापयेत् सप्तदिनानि धान्यगं  
 ततः प्रयोज्यं रसजारणादिकम् ॥

[टोका—जारणायाँ चारविधानमाह—]

जम्बौरबौजपूरकं चाङ्गेरौवेतसाम्लसंयोगात् ।  
 चारा भवन्ति नितरां गर्भदृनिजारणे शस्त्राः<sup>3</sup> ॥

[टोका—रसे विड्योजनमाह—]

विडमधरोत्तरमादौ दत्त्वा सूतस्य चाष्टमांशेन<sup>4</sup> ।  
 कुर्यात्त्वारणमेवं क्रमक्रमादृष्ट्येदग्निम्<sup>5</sup> ॥

(1) A reads व्यवस्थितान् सस्त्रिकठारिकामुखे । B reads व्यवस्थितशस्त्रकठीरिकापुटे ।

(2) A reads बौजपूरकं, which is incorrect. The word बौजपूर is not found in B.

(3) गर्भदृतिकारणा सस्त्रा is an incorrect variant in A.

(4) A has दत्त्वा सूतं चाष्टमांशेन, which is not correct as it destroys the metre as well as the sense.

(5) A reads वर्ष्येदग्निः, which is grammatically incorrect.

अष्टमः पटलः ।

[ठीका—अथ रसरागोऽभिधास्यते—

अभ्रकजौर्णस्य क्षायाविशेषमाह—]

जौर्णाभ्रको<sup>1</sup> रसेन्द्रो

दर्शयति<sup>2</sup> घनानुकम्पिनीं क्षायाम्<sup>3</sup> ।

क्षाणां रक्तां पौत्रां

सितां<sup>4</sup> तथा सङ्करं मिश्राम्<sup>5</sup> ॥

(1) A reads जौर्णाभ्रक, which mars the metre.

(2) A reads दुर्दर्शयति, which is incorrect.

(3) घनानुकम्पिनीं क्षाया is the variant in A. घनानुकपर्च-  
क्षाया is the variant in B. Both the readings seem to be  
incorrect.

(4) क्षाणं रक्तं पौत्रं शितं is the reading in A, which is  
incorrect.

(5) A reads ददा संकरोचिष्ठाः, which is incorrect.

[टीका—अभ्यक्तयोगादर्थविशेषमाह—]

अस्ताभ्यक्तेन वलवत्<sup>1</sup> सितरागैर्युच्चते<sup>2</sup> रसेन्द्रसु ।

श्वेते रक्तैः पीतैः वङ्गैः खलु वर्णतो छेयः<sup>3</sup> ॥

[टीका—अथ रक्ततरसप्रशंसामाह—]

अथ निजमेव हि वर्णं<sup>4</sup>

न जहाति यदा स रज्यते<sup>5</sup> रागैः ।

क्रमशो हि भस्यमाणो<sup>6</sup>

निर्विकृतो<sup>7</sup> रक्तं न लुहते ॥

(1) अस्ताभ्यक्तेन वलवान् is the variant in A, which is incorrect.

(2) A reads श्वितरागैः पूर्वते.

(3) A has नविपुतो छेयं, which has no clear sense.

B has वङ्गवर्णतो छेयः, which mars the metre.

(4) B reads अथ निजकर्णवर्णं, which is not correct.

(5) A reads यथा रसजीव्यते, which is grammatically incorrect.

(6) A reads भस्यमाणा, which is incorrect. B reads कलशो वर्णमाणो, which is also incorrect.

(7) A reads नारको.

[टौका—अभ्यसत्वादैनां योगे रसे अवस्थामाह—]

बलमासेभक्षसत्त्वे जारचरागः प्रतिष्ठितासौक्ष्मा<sup>1</sup> ।

बन्धव सारलोहे<sup>2</sup> सारणमय<sup>3</sup> नागवज्ञाभ्याम्<sup>4</sup> ॥

[टौका—सर्वकरणं तीक्ष्णमाह—]

क्रामति तीक्ष्णेन रसः तीक्ष्णेन<sup>5</sup> जीर्णते चणाङ्गासुः<sup>6</sup> ।

हेक्षो योगिस्त्रीक्ष्म<sup>7</sup> रागान् घट्टाति तीक्ष्णेन ॥

[टौका—तीक्ष्णाहिङ्कुलयोगेन गुणाधिकमाह—]

तदपि च दरदेन इतं इत्वा मात्रौकेण रविसहितम्<sup>8</sup> ।

वासितमपि वासनया घनवज्ञार्थस्तु जार्थस्तु ॥

(1) A reads erroneously प्रतिष्ठिता लोका.

(2) A reads सारचराहे, which is incorrect.

(3) A reads क्रामचमय.

(4) B reads नागवज्ञमतः,

(5) A reads तीक्ष्म च.

(6) A reads यासि, which is incorrect

(7) A reads वीतिसौक्ष्मे, which has a defective metre

(8) B has omitted इत्वा मात्रौकेण रवि.

[टौका—तौक्ष्यावदेनानाह—]

कान्तं वा तौक्ष्यं वा काङ्क्षीं वा वज्रस्यक वापि<sup>1</sup> ।

एकतमं सर्वं वा रसरजने सहूरोऽभौषः<sup>2</sup> ॥

[टौका—खे स्वे विकारे वशमाणमाह—]

कुटिले<sup>3</sup> बलमप्यधिकं रागस्तौक्ष्ये तु पश्चगे खेहः<sup>4</sup> ।

रागस्तेहबलानि तु कमले शंसन्ति धातुविदः<sup>5</sup> ॥

सर्वैरेभिलोहैर्माचिकसहितैर्मृतिस्तथा गर्भे ।

विड्योगेन तु जीर्णे रसराजो विश्वति लोहेषु ॥<sup>6</sup>

[टौका—रसबन्धानां मारणे विधानमाह—]

तालक<sup>7</sup>दरदशिलाभिः खेहचाराम्बलवणसहिताभिः ।

(1) काङ्क्षीं वा वज्रस्यकादीनां, a variant in B.

(2) रसेपि हि रसायने विद्यात्, a variant in A.

(3) This is not found in B.

(4) A reads erroneously पश्चगेह.

(5) A reads धातुविधं, which is incorrect.

(6) This sloka is not found in B.

(7) A reads तारक.

समकाहिगुणविगुणान् पुटो वहेऽङ्गश्चादीन्<sup>1</sup> ॥

[टौका—पुठितधातुकात्यमाह—]

रत्नस्त्रेहनिषेकैः सेकैः कुर्याद्रसस्य पिण्डिरियम्<sup>3</sup> ।

चारणजारणमाचात् कुरुते रसमिन्द्रगोपनिभम् ॥

[टौका—मुख्यत्वेन तास्त्रप्रशंसनमाह—]

अथवा<sup>1</sup> केवलममलं कमलं दरदेन वापितं कुरुते  
विगुणं जीर्णं जौर्णं<sup>5</sup> लाक्षारससन्निभं सूतम् ॥

[टौका—विध्वन्तरमाह—]

रत्नगणगलितपशुजल-

वहु<sup>6</sup>भावितताप्यगम्भकशिक्षानाम्<sup>7</sup> ।

(1) निवाहयेऽङ्गः श्चादीन्, a variant in A, which has a defective metre.

- (2) B reads श्चं.
- (3) A reads छाट्य, which is incorrect.
- (4) B reads erroneously षष्ठ.
- (5) विगुणं हि चोर्णकीर्णं, a variant in B.
- (6) The word वहु is omitted in B, which renders the metre defective.
- (7) A reads गम्भकशिक्षाभिः.

एकेन वापितमृतं<sup>1</sup>

क्रमलं रस्यथि रसराजम् ॥

[टीका—रागाधिकारि-गन्धकादौनाह—]

वाह्णो गन्धकरागो<sup>2</sup> विसुलितरागे<sup>3</sup> मनःशिलातासे ।

मात्रौकं सत्वरसकौ द्वावेतौ<sup>4</sup> रस्ते शस्तौ ॥

[टीका—प्रधानयोः ताम्रसुर्परयोः कात्यमाह—]

क्रमहृदैः रविरसकेः<sup>5</sup> संश्वषो मूकमूचिकाचातः<sup>6</sup> ।

- (1) A reads काष्ठवर्षं, which seems to be incorrect.
- (2) A reads गंधकराग, which is incorrect.
- (3) A reads विसुलितरागेष. B reads विसुलितरागेष. Both the readings are grammatically incorrect.
- (4) B reads नार्चिक, which mars the metre.
- (5) B reads द्राव्ये फि, which seems to be incorrect;
- (6) A reads क्रमहृदैरविरसकेः. B reads क्रमहृदौ रविरसकौ. We have adopted the above reading after collating the texts.
- (7) मूचिकासुनिचातः, a variant in A, which mars the metre. मूकमूचिकाचातौ, a variant in B.

विगुणं जीर्णो जीर्णो<sup>१</sup> हेमाभो जायते<sup>२</sup> सूतः ।

[टीका—अभ्यक्योगमाह—]

अथ<sup>३</sup> छात्ताभ्यक्षूचैँ पुटितं रक्तं भवेत्सथा<sup>४</sup> शकलम् ।

विगुणं जीर्णो जीर्णो<sup>५</sup> हेमद्रृतिसंनिभः सूतः<sup>६</sup> ॥

[टीका—स्वर्चमारणमाह—]

विगुणेन मात्रिकेन तु कनकं च सूतं रसतालयुतम्<sup>७</sup> ।

पटुसहितं तत् पक्षं इक्षिकया यावदिन्द्रगोपनिभम् ॥

(1) A reads जीर्णे जीर्णे. B reads जीर्णो जीर्णो.

(2) A reads धृतिहेमनिभी भवेत्, (धृति—द्रुत). B reads इमवर्चाभो जायते, which mars the metre.

(3) A reads चबदा, which destroys the metre.

(4) A omits तथा.

(5) A reads जीर्णे जीर्णे, which seems to be incorrect.

B reads जीर्णो जीर्णो.

(6) हेमधृति(?)संनिभो भवेत् सूतः, a variant in A.

(7) कनकस रसतालयुतम्, a variant in A, which is a defective metre. The reading of B, which we have adopted, is also a defective metre. The word चेत् or लात् should be added after the word युतम्.

[टौका—एतद्वार्ताजौर्यसूतस्य लक्षणमाह—]  
 तच्चूर्णं सूतवरे द्विगुणं जीर्णं हि<sup>1</sup> जीर्णं तु ।  
 द्रुतहेमनिभः सूतो<sup>2</sup> रज्यति लोहानि सर्वाणि<sup>3</sup> ॥  
 [टौका—सब्बेषां धातूनां रसानामुत्तरोत्तरविशेषत्व-  
 माह—]  
 पवादष्टगुणं सत्त्वं सत्त्वादष्टगुणं द्रुतिः ।  
 द्रुतेरष्टगुणं वीजं तत्त्वादवीजं तु जारयेत् ॥

(1) A reads जीर्णं तु. B reads जीर्णं हि.

(2) द्रुतहेमनिभस्तो, a variant in A, which seems to be incorrect.

(3) A has जरति लोहानि सत्त्वानि. B has रज्यति लोहानि सर्वाणि. Both the readings have defective metre.

(4) This verse is found in A after the verse तारक-  
 दरद्विलाभिः &c, (vide ante pp 28—29) and runs thus :—

पवादष्टगुणं दस्ता सत्त्वादष्टगुणं द्रुतिः ।

द्रुतेरष्टगुणं वीजं तत्त्वादवीजं तु जारयेत् ॥

नवमः पठलः ।

[ टीका—बौजप्रश्नसनमाह— ]

इति रक्तोपि रसेन्द्रो बौजेन विना न कर्म्मकदभवति ।

हिविधं तत् पौतसित<sup>1</sup> नियुच्यते सिद्धयेच्च रसम्<sup>2</sup> ॥

[ टीका—रसोपरसधातूनां बहुविधत्वात् शोधन-  
माह-- ]

तस्य विशुद्धिर्बहुधाः<sup>3</sup> गगनरसोपरसलोहचूर्णेष्व ।

हिविधं वौजं तैरपि नाशुद्धैः शुद्धते कदाचिदपि<sup>4</sup> ॥

[ टीका—अशुद्धबौजप्रभावमाह— ]

यः पुनरेतैः कुरुते कर्म्माशुद्धैर्भवेद्रसस्तस्य ।

- (1) B reads पीतं सितं which destroys the metre.  
 (2) नियुधये सिद्धयेच्च रसः, an incorrect variant in A.  
 नियुच्यते सिद्धसेव तत्, a variant in B. Both texts are collated in our adopted reading.

(3) रसति शुद्धिर्बाचा, a variant in A, wherein the first term seems to be incorrect.

(4) B reads नैतत् instead of कदाचिदपि. This is incorrect ; since it contains two negatives.

अव्यापकः पतङ्गो<sup>१</sup> न रसे न रसायने योग्यः<sup>२</sup> ॥

[ टीका—रससंचकानाह— ]

वैक्रान्तकान्तं संशकमाचिकं विमलाद्विदरद-  
रसकाच<sup>३</sup> ।

अष्टौ रसास्तथेषां सत्त्वानि<sup>४</sup> रसायनानि स्तुः ॥

[ टीका—उपरससंचकानाह— ]

गन्धकगैरिकसुशिला<sup>५</sup> चितिष्ठेचरमप्लगच  
कहु उभम् ।

उपरससंचमिदं<sup>६</sup> स्यात् शिष्मिश्यन्ते सारलोहाख्यौ ॥

- (1) अव्यापकपतंगि, a variant in A, which is incorrect.
- (2) A reads योज्ये. B reads रसापनयने योग्यः. Both the readings are incorrect.
- (3) A omits काच,
- (4) A reads माचौक, which mars the metre.
- (5) A reads द्विदरसकैष.
- (6) A reads चत्वारि, which is not accurate.
- (7) B reads शिष्मालक, which destroys the metre.
- (8) B reads संशकमिदं, which mars the metre.

[ टौका—पूतिसंज्ञके आह— ]

ताम्बारतौच्छाकाम्ताभवजुलोहानि<sup>1</sup> नागवङ्गौ च<sup>2</sup> ।  
कथितौ च पूतिसंज्ञौ<sup>3</sup> तेषां संशोधनं कार्यम् ॥

[ टौका—लवणाकारसंज्ञे आह— ]

सौवर्णलसेभवकं चूलिकसामुद्रोमकविडानि ।  
षड्लवणान्येतानि तु सर्जीयवटकृष्णाः चाराः ॥<sup>4</sup>

[ टौका—शोधकद्रावकगणमाह— ]

सूर्यावर्त्तः<sup>5</sup> कदली कन्या<sup>6</sup> कोशातकी च सुरदाळी ।  
शौश्रुष<sup>7</sup> वज्रकट्टो नौरकणा काचमाची च ॥  
आसामिकरसेन तु लवणाकाराम्त्रान्विता बहुयः ।  
शुद्धनिति रसोपरसा भाता मुखनि सत्त्वानि ॥<sup>8</sup>

(1) B reads सल्लोहानि.

(2) B reads वङ्गनागो च.

(3) B reads कथितौ कुमूतसंज्ञौ, which is incorrect.

(4) This verse is not found in A.

(5) A reads सूर्यावर्त्तक.

(6) B reads वन्या.

(7) A reads शिशुष.

(8) This verse is found in A only.

[ टीका—शोधकद्रावकाणां शोधनद्रावणविधान-  
माह— ]

स्त्रियं सच्चाराम्बैः<sup>1</sup> धातं वैक्रान्तकं हठाद्रुवति<sup>2</sup> ।  
तद् द्रुतमात्रं<sup>3</sup> शुध्यति कान्तं शशरक्तभावनया ॥

[ टीका—तच्चाह— ]

सत्यकमपि रक्तगणे:<sup>4</sup> सुभावितं स्त्रेहरागसंयुक्तम्<sup>5</sup> ।  
शुध्यति वारैः<sup>6</sup> सप्तभिरतः परं युच्यते कार्ये<sup>7</sup> ॥

[ टीका—तच्चाह— ]

च्चारैः स्त्रेहरादी पश्चादान्तेन<sup>8</sup> भावितं विमलम् ।

(1) A reads सच्चाराम्बे.

(2) A reads हठाद्रुवति, which is incorrect.

(3) A reads तद्रुतमात्रे, which is incorrect.

(4) B reads रसुगणैः, which seems to be incorrect.

(5) भावनतः स्त्रेहरागसंस्थितं, a variant in A.

(6) A reads रागैः.

(7) सप्तभिस्तः परं योक्तयैत् कार्ये, a variant in A, which mars the metre. B reads सप्तभिरभितः परं, wherein अभितः is incorrect as well as a defective metre.

(8) B reads पश्चात् उच्चेन.

शुद्धति तथा च रसकं दरदं मान्त्रौकमयेवम्<sup>1</sup> ॥

[ टौका—ताम्बशोधनमाह— ]

ततुरविपत्रं लिङ्मं<sup>2</sup> लवणाकारान्तरविस्तुक्षीरैः<sup>3</sup> ।

आतं निर्गुण्डौरससिक्तं बहुशो वहेद्द्रवत्वच्छुः<sup>4</sup> ॥

[ टौका—लोहशोधनमाह— ]

शुद्धति नागो वज्ञो घोषो रविणा च वारमुनिसंख्यैः<sup>5</sup> ।

निर्गुण्डौरससेकै स्तम्भूलरजःप्रवापैष्य ॥

[ टौका—तज्जाह— ]

(1) दरदमान्त्रौकमयेवं तथा शुद्धान्ति, a variant in A, wherein the last two words are superfluous and incorrect.

(2) B reads ततुरपि पवस्त्रैः, which has no sense.

(3) A reads कुड्हि. B reads कुड्हा. Both the readings destroy the metre.

(4) A reads बहुशो वहेद्रकं. B reads बहुशो द्रवत्वच्छु. Both the readings are defective.

(5) घोषो रविरौधमयि च मुनिसंख्यैः, a variant in A. B reads रविणा च वारमुनिभिः. Both the readings are incorrect.

(6) B reads सिक्ते, which is not correct.

रक्षगणगलितपशुजलमावितपुटितं च रक्षते<sup>1</sup> तौख्यम् ।

शुद्धति कदलीश्चिरसभावितपुटितं<sup>2</sup> लिभिर्बाहेः ॥

[ टीका—मारणमाह— ]

सर्वे: शुद्धति लोहो रक्षते<sup>3</sup> सुरगोपसचिभो वापात् ।

माचिकसत्त्वे भृङ्गं<sup>4</sup> शुखं वा गन्धकेन इतम्<sup>5</sup> ॥

एकादशः पठलः ।

क्षागाखिभस्मनिर्मितमूषां क्षत्वैवामलकाकारां ।

दलयोगे घनरध्नां टंकणविषगुज्जक्षत्वेपां ।

(1) A reads रक्षते, which is incorrect.

(2) शुद्धति कदलीलाश्चिरसभावितं पुटितं, an incorrect variant in B.

(3) A and B read रक्षति, which is grammatically incorrect.

(4) A reads भृङ्गं. B reads दरद्दन भः Both are unintelligible.

(5) A reads शुखेन वा गन्धकेन इति. B reads चरति.

[ टौका—अथ अन्यकारयितुर्वंशवर्णनमाह— ]  
शौतांशुवंशसश्वहैश्यकुलजमजनितकुलं महिमा ।

अयति श्रीमदनरथः<sup>2</sup> किरातनाथो रसाचार्यः ॥

[ टौका—अथ चास्य कारयितुर्गुणवर्णनमाह— ]  
यस्य स्त्वयमवतोर्णा रसविद्या सकलमङ्गलाधारा<sup>3</sup> ।  
परमश्चेयसहेतुः श्रेयसि परमेष्ठिनः पूर्वेभृ<sup>4</sup> ॥  
येन चतुर्वर्णस्त्वे च्छादिव्याधादिलभ्यसत्वाभम्<sup>5</sup> ।  
दक्षिणरसा गृहीता<sup>6</sup> आदिवराहेणेव महाप्रसये ॥<sup>7</sup>

- (1) कुल is not found in B.
- (2) स अयति श्रीमदनश्च, a variant in B.
- (3) C reads सकलमङ्गलाधारा.
- (4) Of the latter half C has only परं सहेतुः.
- (5) C reads चतुर्वर्णस्त्वे च्छादिव्यदाततव्यसत्वाभम्, which seems to be incorrect. Cf. Patala I., in which the following verse is given :—किरातगीपादिकतापसाद्यवनेवराकात्कुशलासाधाये । विदन्ति नामाविद्यमेषजानां प्रमाणवर्णाङ्गतिनामजातौः ॥
- (6) दक्षिणरस गृहीता is the incorrect reading in C.  
[In the case of किरातनाथ रसाः गृहीताः i. e. collected रस—mercury, minerals &c. and दक्षिण is favorable , and in the case of आदिवराह रसा गृहीता i. e. lifted up the earth.]
- (7) This verse and the next are not found in B.

नष्टशरीरविवर्णा हीनाङ्गाः कुण्डिनो गुच्छाद्यस्त ।

अभिनवसोमेष्वरतामापुरपि पुनर्नवेरङ्गैः ॥

[ टौका—कर्त्ता स्वनाममहस्यं सूचयन्नाह— ]

तस्मात् किरातन्त्रपतेः बहुमानमवाप्य रससुकर्मरतः<sup>1</sup> ।

रसहृदयाख्यं तन्म<sup>2</sup> विरचितवान् भिल्लुगोविन्दः<sup>3</sup> ॥

नमा मङ्गलविष्णोः सुमनोविष्णोः सुतेन तन्मोयम्<sup>4</sup> ।

श्रीगोविन्देन ज्ञातः<sup>5</sup> तथागतः श्रेयसे भूयात् ॥<sup>6</sup>

अष्टादशसंस्कारं रसेन्द्रदेवस्य दिव्यतनु दृष्टा ।

लिखितमिदं पुण्यतमं रसहृदयमवाप्यते सकालम् ॥

(1) C reads रसकर्मैपदेशतो दृष्टा, which destroys the metre.

(2) C reads रसहृदयेष्वान्तं, which seems to be incorrect.

(3) C reads विरचिताया भगवद्गोविन्दः, which is incorrect.

(4) C has रसाटव्यनाम तन्मोयम्, which is incorrect.

(5) C has श्रीमद्भगवद्गोविन्देन ज्ञातं, which mars the metre.

(6) This verse and the next are not found in B.

इति श्रीमद्भगवद्गोविन्दविरचितं

रसहृदयं समाप्तम् ।<sup>1</sup>

शुभसलु ।

संवत् १६०४ समये ज्येष्ठ वदि १३ भौमे  
जगद्वायथभट्ट लेखि ॥

श्रीराम हाल संवत् १८८० पौष वदि ५ भौमे ।

- (1) MS. A ends abruptly with the colophon, which runs thus :—इति श्रीगोविन्दभगवत्पादविरचिते रसहृदये जीर्णरस-क्रियाचिकार एकविंशतितमः पठतः ॥ The author's account of himself is altogether wanting in it. B has “इति सकल-रैसवेद्यकुलकिरीठभूषायमाणारुपपादपश्चरागमकलविद्यापारोण श्रीमद्भिक्ष-गोविन्दङ्कनी रसहृदयः समाप्तः । इति श्रीमद्भुक्तुरलबंशपथीचिभुषाकृ-नियमहेश्वामवद्वीचतुर्भुजविरचितार्था ... ... ... खण्डे वाला-नवयवीचिकास्यार्था रसहृदयठोकार्था रसप्रशंसात्मक एकीनविश्वीद्वीधः । डात श्रीः” ॥

# Extracts from KAKACHANDESVARIMATA.

काकचण्डेश्वरीमततन्वात्

समृद्धताः श्रोकाः ।

ॐ नमः सदाशिवाय ।

कैलासशिखरासौनमुमा रुद्रं जगद्गुरुम् ।  
क्रांदनंदैमहाकालौ भूंगचण्डौविनायकौ ॥ १ ॥  
योगिनौनामष्ट तत्र गुह्याद्गुह्यतरं परम् ।  
कपालौ कालरात्रौ च कालचंद्रकलाम्बिका<sup>१</sup> ॥ २ ॥  
करालौ कालकर्णी च काकचण्डेश्वरौ तथा ।  
एवमादिस्तथा चान्या योगिनौगणगुह्यकौ<sup>२</sup> ॥ ३ ॥

(1) The text reads कालचंद्रकम्बिका, which is incorrect.

(2) The text reads गुह्यकौ, which is incorrect.

नृत्यवाद्य सुखेशामैः सानन्दैर्हृष्टचे तसैः ।  
 तत्रस्य भैरवं देवं योगिनीगणवेष्टितम् ॥ ४ ॥  
 केचित् सुवन्ति संहृष्टाः केचिद्गायन्ति गुद्धकाः ।  
 केचिद्बृत्यन्ति गुद्धा ये केचिद्वाद्यं न कुर्वते ॥ ५ ॥  
 हृषितं<sup>१</sup> भैरवं देवं पञ्चवक्त्रं विलोचनम् ।  
 तं हृष्टा भैरवी हृष्टा जगतां विदश्शरी ॥ ६ ॥  
 क्षताच्छलिपुष्टा भूत्वा क्षणतारकलोचना ।  
 काकचण्डेश्वरी देवी उवाचेदं तु भैरवी ॥ ७ ॥

काकचण्डेश्वरी उवाच ।

भगवन् देवदेवेश सर्वज्ञ सर्वविच्छिव<sup>२</sup> ।  
 सर्वज्ञानप्रकाशाय अहं पृच्छामि शंकर ॥ ८ ॥  
 कथं कायस्थितो जीवो जीवकोऽसौ प्रकौर्त्तिः ।  
 कायस्थः कर्मणा केन स्थितः संसारयंजरे ॥ ९ ॥  
 जराव्याधिदारिद्रेण ग्रस्तः संसारबंधनैः ।  
 एको ब्रजति यानेन एकः स्कंधे वष्टेष्व तम् ॥ १० ॥

- (1) The text reads हृष्टन्, which is not correct.
- (2) The text reads सर्वच्छिवः, which is not correct.

जयजयश्वं मांगस्यमेकस्याने च जंतवः ।  
 किं कुर्वाणाः प्रकुर्वाणाः कस्याच्चे ब्रूहि शंकर ॥ ११ ॥

श्रीसर्वज्ञ उवाच ।

शृणु त्वं काकचामुडे साधकानां हितं प्रिये ।  
 गुद्धाद्गुद्धतरं वाक्यं पृष्ठोऽहं तु वरानने ॥ १२ ॥

कथयामि समासेन शृणु त्वं काकचंडिके<sup>१</sup> ।  
 यस्यायंश्च परो नित्यः अनादिनिधनेष्वरः ॥ १३ ॥

सुरुपो निर्गुणः शांतो विश्वव्यापौ परात्परः ।  
 अनादिकर्मसंबंधः कायस्यो भवते तु सः ॥ १४ ॥

जौवि व्याधिभयं कर्म अज्ञानात् संप्रकोर्त्तिम् ।  
 तस्मात् कर्मभवात् क्लिष्टः संसारे संसरेत्तु सः ॥ १५ ॥

करोति<sup>२</sup> विविधं कर्म संसारे काममोहितः ।  
 द्रव्योपायं न जानाति कामभोगार्थहेतुना ॥ १६ ॥

काय<sup>३</sup>क्लेशेन मानव्यो द्रव्योपायं करोति सः ।  
 क्षणिकाण्ड्यसेवायां मेषाविक्रयविक्रये ॥ १७ ॥

- (1) The text reads काकचंते, which is incorrect.
- (2) The text reads करोतु, which is not accurate.
- (3) The text reads कालक्लेशेन, which is not correct.

वहन्ति काष्ठभारांश्च दृष्टिभारमनेकधा ।  
 यानं यवनच्छत्रं<sup>१</sup> च किं करोति<sup>२</sup> करोति सः ॥१८॥  
 कामासक्तनरः श्रीमान् कुरुते कर्म नैकधा<sup>३</sup> ।  
 कुर्वाणांश्च नराः केचित् कामासक्तार्थचिन्तकाः ॥१९॥  
 जायते मत्यंलोकेस्मिन् दारिद्रोपहतचेतसः ।  
 जायते नाश संदेहो कुञ्जखंजा नपुंसकाः ॥ २० ॥  
 महासंसारबंधेन त्रिगुणेन सुयंचिताः ।  
 अटव्यां घोरसंघट्टघाटिकां तु नयन्ति तत् ॥ २१ ॥  
 एतस्मे कथितं भद्रे यत्त्वं मां परिपृच्छसि ।  
 किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ २२ ॥  
 इति काकचंडेश्वरीमते प्रथमः पटलः ।

श्रीकाकचंडी उवाच ।

कथयस्त्वा महादेव कामभोगप्रसाधनः ।  
 अर्थः संपद्यते येन अङ्गोशात् परमेश्वर ॥ १ ॥

- (1) The text reads यवनक्षत्रं, which is incorrect.
- (2) The text reads किं कुरुते, which is incorrect.
- (3) The text reads कुरु कर्मनेकधा, which is incorrect.

तदहं श्रोतुमिच्छामि कथयस्त्र प्रसादतः ।  
 आकाशगमनं देव खेचरत्वं यथा भवेत् ॥ २ ॥  
 पादुकाया दले पञ्चदिव्यस्त्रीकामसाधनम् ।  
 रोचनं अंजनं चैव धातुवादरसायनम् ॥ ३ ॥  
 जलूकाबंधमित्याहुः रसस्य मारणं कथम् ।  
 जारणं रद्धकत्तृत्वं वज्रभद्रावणं कथम् ॥ ४ ॥  
 एतत् सर्वं समासेन छूहि मे त्रिपुरांतक ।

### श्रीभैरव उवाच ।

शृणु त्वं काकचामुडे साधकानां हितं प्रिये ॥ ५ ॥  
 कथयामि समासेन पृथक् सिद्धार्थसाधनम् ।  
 न द्रव्येण विना सिद्धिर्न भोगाः काम एव च ॥ ६ ॥  
 द्रव्यहीना नरा मत्ये प्रेतरूपेण संस्थिताः ।  
 अटंति मत्यलोकेस्मिन् पर्युपद्रवकारणम् ॥ ७ ॥  
 \* \* \* विवं (?) तेषां जायतोपि नृतश्रुतेः ।  
 कुलं सौभाग्यरूपं च पांडित्यं ज्ञानसंस्थितम् ॥ ८ ॥  
 द्रव्यहीना न श्रोभन्ते प्राणहीना नरा यथा ।  
 कुम्भितो ब्राणहीनोपि केनापि वधिराः स्थिताः ॥ ९ ॥

पद्यंते मर्त्यलोकेभिन् द्रव्यस्यं मकारध्वजम् ।  
 तस्मात् संसाधयेहेवि रसेन्द्रं साधकोत्तमः ॥ १० ॥  
 अथातः संप्रवच्चामि रसेन्द्रसाधनं तत्र ।  
 मारणं जारणाद्यं च द्रव्यसाधनमुत्तमम् ॥ ११ ॥  
 वच्छदंडः सुदंडश्च लोहदंडस्थथेव च ।  
 व्रयो विना ओषधये रसस्य मारणे हिताः ॥ १२ ॥  
 ताङ्गिबोध समासेन यथा जानन्ति साधकाः ।  
 वज्रदंडस्तु वज्रौ स्यात् लोहदंडं पुटं विडः ॥ १३ ॥  
 सुदंडं ब्रह्मदंडं च समासात् कोर्त्तिं तत्र ।  
 ग्राहयेत्तं समासेन साधकां छृष्टमानसः ॥ १४ ॥  
 तद्रसं रससंयुक्तं एकौक्षत्य तु मर्दयेत् ।  
 अंधमूषागतं धातं रसं मियेत तत्त्वणात् ॥ १५ ॥  
 सहस्रवेधी कर्त्ता च ज्ञायते स महारसः ।  
 मूषां संलेपयेत् तेन पुराणद्वा महीषधीः ॥ १६ ॥  
 अंधयित्वाभिन्मध्ये तु रतिबंधः अयं विधिः ।  
 पश्चात् पलसहस्रैकं शुखस्य ग्राहयेद्बुधः ॥ १७ ॥  
 अन्तर्वर्गं हतं शुखं द्वारवर्गं हतं शुभम् ।  
 वज्रौद्वीराक्षीरेण मर्दयेत् शतधा नरः ॥ १८ ॥

पुटं द्व्यात् समावेन कालिकारहितं भवेत् ।  
 मूषागर्भोदरे चिष्ठा धामयेत् यदिरानस्तः ॥ १८ ॥  
 रसेन्द्रः चिप्यते तच तारं संजायते चर्षात् ।  
 अथातः संप्रवस्थामि मूषाबंधं यथा भवेत् ॥ १९ ॥  
 मृत्तिकाः याहयेत् प्राञ्छस्तुलपाषाणवर्जिताः ।  
 तुषादन्धास्तयो चाष्टा मृद्भागसु चयस्तथा ॥ २१ ॥  
 एकोक्तात्य तु संबंधे मूषां तत् कारयेद्बुधः ।  
 गोद्धनाकारसद्गौमथवामलकं कुरु ॥ २२ ॥  
 मूषाबंधमिति स्थातं साधकानां हिताय वै ।  
 अथान्यत् संप्रवस्थामि रसस्य मारणं यथा ॥ २३ ॥  
 याहयेत् पूर्ववद्भूयः ओषधीस्तिस्तः साधकः ।  
 मूषां संखेपयेत् तेन धात्य कर्म समाचरेत् ॥ २४ ॥  
 रसेन्द्रो चियते चिप्रं कुरु कर्म यदिच्छया ।  
 वीतोदकेन कामेन हेमकर्माणि वा शूणु ॥ २५ ॥  
 कारयेत्तोहमयं पाचं तस्योर्हं मृत्ययं शुभे ।  
 अग्नोन्यपृष्ठसंलग्नं कारयेत् साधकोत्तमः ॥ २६ ॥  
 अधोयन्त्रेण तं धात्य आयसं तत्र जारयेत् ।  
 तपस्त्वोदरे दृष्टं जरते नाच संशयः ॥ २७ ॥

तदगुणं आयसं तच हेमं चाषगुणं ददेत् ।  
 खौरवज् तथा चारौ षट्जारौ उदिरपहो । (?)  
 आहयित्वा रसं तेषां आयसं जारयेन्नरः ॥ २८ ॥  
 हेमं संजायते तच धर्मकामार्थसाधनं ।  
 वृद्ध खल्वोदरे तप्ते हेमं षड्सुणतां भजेत् ॥ २९ ॥  
 पुरा महौषधैर्युक्तं जरते नाव्र संशयः ।  
 आरिते सारितं दद्यात् पुनस्तं जारयेद्याद् ॥ ३० ॥  
 कुरुते कर्मसंबंधं कर्म सिद्धार्थसाधनं ॥ ३१ ॥  
 जारणं मारणं चेव समासात् कौत्तिं मया ।  
 किमन्यत् पृच्छसे भद्रे तथा ते कथयाम्यहम् ॥ ३२ ॥

इति श्रीकाकचंडेश्वरौमते हितौयः पटलः ।  
 अथावं संप्रवश्यामि अभ्रकस्य यथाक्रमम् ॥ २० ॥  
 द्रावणं अभ्रकस्येव समासेन विघ्नीयते ।  
 खौरकंचुकिचूर्णेन तदसेनाभिभावितं ॥ २१ ॥  
 निर्गुण्डौवजूदण्डं तु तदसे भावितं कुरु ।  
 एकैकं सप्तवारैस्तु भावयेत् साधकोत्तमः ॥ २२ ॥  
 (भावनाम्ब) अभ्रकस्य यन्म्बे श्विपेहिनवयं ।  
 वृहत्या सप्तरात्रं तु श्विपेदभ्यं नरोत्तमः ॥ २३ ॥

तेन कल्केन पद्माणि लेपयेदभकस्य च ।  
 कांस्यपात्रेण \* \* \* स्तारे साधकोत्तमः ॥ २४ ॥  
 सूर्यधान्ति ततो धायः सप्ताहं साधकोत्तमः ।  
 द्रवते नाव संदेहः प्रियं दृष्ट्वा यथा स्त्रियः ॥ २५ ॥  
 रसस्य भागमेकं तु द्रुतभागसमं कुरु ।  
 एकौकृत्य तु तत्त्वास्यं मियते नाव संशयः ॥ २६ ॥  
 लक्षांशब्देभकोऽसौ हि जायते नाव संशयः ।  
 अथान्यं संप्रवस्थामि यथा संजायते द्रुतिः ॥ २७ ॥  
 आहयेदभकं प्राञ्छः पौतं वा कृष्णमेव वा ।  
 पुरा मंस्कारयुक्तं तु कर्त्तव्यं साधकेन तु ॥ २८ ॥  
 यवासा चित्रकं धारः कंचुकीवज्रदण्डयोः ।  
 वज्रकंदाकर्क्षीरं च भज्ञातं टंकणं तथा ॥ २९ ॥  
 चारवयममायुक्तं पट्पंचसमन्वितं ।  
 एकौकृत्य तु कल्केन अभ्यपद्माणि लेपयेत् ॥ ३० ॥  
 मूषागर्भोदरे चित्रा धामयेत् खादिरानलैः ।  
 द्रवते नाव संदेहो \* \* \* \* \*  
 इति काकचंडेश्वरीमते षष्ठः पटलः ।

# Extracts from RASENDRACHUDAMANI.

सोमदेवविरचितात् रसेन्द्रचूडामणः  
उद्भूताः श्लोकाः ।

रुप्येण सह संयुक्तं धातं रुप्येण चेष्टगीत्<sup>1</sup> ।  
तदा निरुप्यमित्युक्तं लोहं तदपुनर्भवम् ॥  
एवं रुप्यं सनागं चेत् धातं ताम्बे लगेन्नहि ॥

निष्कमावे तु नागेऽस्मिन् लोहखार्थां छृते सति ।  
खतो लक्षणां हैमीं शलाकां यसति ध्रुवम् ॥  
कुसुभतैलतसं तत् खर्णमुहिरति<sup>2</sup> ध्रुवम् ।  
गुणनागोऽयमुहिष्ठो वक्ति<sup>3</sup> सच्छृद्भैरवः ॥

(1) The text reads चषु. But रसरबसमुदय reads चर्षति, which seems to be correct.

(2) The text reads खर्णे मुहिरिं, which is incorrect.

(3) The text reads मुहिष्ठशक्ति, which has no sense.

तौल्यं नीलाञ्जनोपेतं धातं हि बहुशो दृढम् ।  
 ऋदुक्षाणां द्रुतद्रावै<sup>1</sup> वरनागं तदुच्चते ॥  
 ऋतस्य पुनरहङ्कृतिः संप्रीक्षोत्यापनास्थया<sup>2</sup> ।  
 द्रुतद्रव्यस्य निहेपो द्रवे तड्डालनं मतम् ॥  
 चिंशतपलमितं नागं भानुदुर्घेन महितम् ।  
 विमर्हं पुटयेत्तावत् यावत् कर्षावशेषितम् ॥  
 न तत् पुटसहस्रेण द्वयमायाति सर्वथा<sup>3</sup> ।  
 चपलोऽयं समुहिष्ठो वार्त्तिकैर्नागसम्भवः<sup>4</sup> ॥  
 इत्यं हि चपलः<sup>5</sup> कार्यी वङ्गस्यापि न संशयः ।  
 तत् स्पृष्टहस्तासंसुष्टः केवलो बधते रसः ॥

(1) The text has द्रुतद्रावै, which is incorrect. We have adopted the text of रसरबसमुच्चय.

(2) The text reads साधीक्षस्यापनास्थया, which seems to be erroneous.

(3) The text has द्वयमायाति सर्वदा, which is grammatically incorrect.

(4) The text reads मार्गसंभवः, which is incorrect.

(5) The text reads इत्यं शीरपलः, which is senseless.

स रसो धातुवादेषु शस्यते न रसायने<sup>1</sup> ।  
 अयं हि खर्पशास्येन<sup>2</sup> लोकनाथेन कीर्तिः ॥  
 भ्रामकाख्यरजः सूक्ष्मं पञ्चमांशरसान्वितम् ।  
 कुमारौभूलतोयेन मर्हयेदेकवासरम् ॥  
 चाङ्गेत्रौखरसेनापि दिनमेकमनारतम्<sup>3</sup> ।  
 एवं भूनागधातेन मर्हयेहिवसहयम् ॥  
 अथैकपलमानेन तावता लपुष्णापि च ।  
 दशनिष्करसेन्द्रेण शश्यपिष्ठौं समाचरेत् ॥  
 योजयित्वाथ कल्केन यथापूर्वं विमर्हयेत् ।  
 ततः साररसेन्द्रेण सर्वेन रसकस्य च ।  
 पिष्ठौं क्षत्वा तु पूर्वेण पूर्वकल्केन योजयेत् ॥  
 अथ प्रश्नास्य कोण्ठेन<sup>4</sup> काञ्जिकेन प्रशोषयेत् ।

- (1) The text has रसायनम्.
- (2) खर्पशास्येन is the reading in रसरबसमुच्चय.
- (3) The text reads दिनमेकमनारसम्, which has no clear sense.
- (4) The text reads सौहेन, which is unintelligible.

पलार्शशुद्धस्येन भृष्टगुच्छारसेन च ।  
 विमर्हं काञ्जिके कुर्यात् मरिचप्रमितां गुटीम्<sup>1</sup> ॥  
 निरुध वज्रमूषायां सन्धिदन्वं विधाय च ।  
 शुषिरैर्नवभिः<sup>2</sup> सम्यग्भस्त्राभ्यां च धमेत् खलु ॥  
 ततो मूषागतं सत्त्वं समादाय समन्ततः ।  
 धमेत् प्रकटमूषायां वज्रनालेन शुद्धये ॥  
 दशशाणं हि तत्सत्त्वं भस्त्रना लवणेन च ।  
 सकाञ्जिकेन संवेष्य पुटयोगेन शोधयेत् ॥  
 हिनिष्कप्रमिते तस्मिन् पूर्वप्रोक्तेन भस्त्रना ।  
 अशौतिगुणितं नागं धात्वा निर्वाहयेत् खलु ॥  
 इयताः<sup>3</sup> पूर्वसूतोऽसौ जीयते न कथम्भून ।  
 चपलोऽयं समुद्दिष्टो लोकनाथेन शश्मुना ॥  
 अनेनापि रसः शौघ्रुं बधते पूर्ववत् खलु ।  
 कारवज्जीजटाद्यैर्दशधा पुष्टितो हि सः ।  
 भवेद्वागविनिर्मलो ग्रासं गृह्णात्यशेषतः ॥

- (1) The text reads मरिचप्रमिता गुटी, which is incorrect.
- (2) The text reads शिशिरैर्नवभिः, which has no sense.
- (3) The text reads इयमा, which is incorrect.

सुखं प्रकटमूषायां भवेत् विगुणोत्तरम्<sup>1</sup> ।  
जीर्णग्रासो रसोऽप्तेष देहलोहकरो भवेत् ॥  
सोऽयं श्रीसोमदेवेन कथितोऽतौव निश्चितम् ॥  
भूभुजङ्गशक्तियोऽप्रक्षाल्यापद्धतिः<sup>2</sup> रजः ।  
क्षाणवर्णं हि तत् प्रोक्तं धौताख्यं<sup>4</sup> रसवादिभिः ॥

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खरूपस्य विनाशेन पिष्टतापादनं हि यत् ।  
विघ्निर्वर्जितः<sup>5</sup> सूतो नष्टपिष्टः स उच्यते ॥  
अथ यन्माणि वक्ष्यन्ते रसतन्माण्यनेकशः<sup>6</sup> ।  
समालोक्य समासेन सोमदेवेन सांप्रतम् ॥

- (1) The text reads विगुणोत्तरा, which is incorrect.
- (2) The text reads ताये, which is not accurate.
- (3) The text has अपद्धतं which is not accurate.
- (4) The text reads धौताख्यं, which is not correct.
- (5) But रक्तरक्तमुद्यम reads विहिनिर्वितः.
- (6) But रक्तरक्तमुद्यम reads अद्वितः.

जर्हपातनयन्त्रं हि नन्दिना परिकौर्त्तिम् ॥

कोष्ठ(ष्ट)कायमेतदि नन्दिना परिकौर्त्तिम् ॥

विष्वाद्रौ हिमपर्वते च मलये गोमन्तके श्रीगिरौ  
सद्याद्रावथ पारियाचकगिरौ किंकिंधिनामालये ।  
माहेन्द्रेऽप्यथ चाल्यवत् त्रितिधरे तदूपनामाधिकं  
गोपाभीरकसिद्धवैद्यमुखतो वैद्यः समावैद्यताम् ॥

इति श्रीकरवालभैरवपुरवरपतिश्रीसोमदेवविरचिते  
रसेन्द्रचूडामणी रससूवख्याने रसमहिम-  
निरूपणं नाम प्रथमोऽध्यायः  
समाप्तः ।

# Extracts from RASAPRAKASASUDHAKARA.

यशोधरविरचितात् रसप्रकाशसुधाकरात्  
उडृताः श्लोकाः ।

विमलसूतवरो हि पलाष्टकं  
तदनु धातुघटीपटकांक्षिकाः ।  
पृथगिमाश्च चतुःपलभागिकाः  
स्फटिकशुद्धपलाष्टसमन्विताः ।  
मह जलेन विमर्द्य च यामकं  
लवणकाञ्जलेन विमिश्रितम् ।  
उदितधातुगणस्य च मूषिकां  
कुरु रसं विनिवेश्य तथ व ।  
उमर्हकाभिधयन्त्रवरेण तं  
द्विदशयाममजाचयवङ्गिना ।  
पवनपित्तकफङ्गयकारकं  
सकलरोगहरं परमं सदा ।

गजपतेर्बलवदुबलदो नृणां  
 हि जपतीक्षणवद्यनप्रदः ।  
 युवतिकामविलासविधायको  
 भवति स्त्रूतवरः स्त्रुतदः सदा ।  
 सघनसाररसः किल कान्तिद-  
 स्त्रुतस्त्रुतकुष्ठहरः कथितो मया ॥  
 इति कर्पुररसः ॥

उदयभास्करनामरसो स्थयं  
 भवति रोगविधान्तकरः स्थयम् ।  
 मगधिकामधुना सह गुच्छिका-  
 वयमितश्च सदा परिसेवितः ।  
 लस्तिकामविलासविधायकः  
 स्त्रविरकोऽपि इतौ तत्त्वाणायते ॥  
 गदहरो बलदोऽपि हि वर्णदो  
 भवति कर्मविपाकजरोगङ्गा ।  
 सवस्त्रुतकशास्त्रविमन्तजो  
 हिन्दवरेष्व मया प्रकटीकृतः ।  
 इति उदयभास्कररसः ॥

## HINDU CHEMISTRY

अदेहानीं प्रवस्यामि धातुशोधनमारणम् ।  
 अनुभूतं मया किञ्चित् किञ्चिच्छास्तानुसारतः ॥  
 सुवर्णं रजतं चेति लोहं शुद्धसुदोरयेत् ।  
 ताम्बं चैवाश्मसारस्त्रं नागवङ्गौ तथैव च ॥  
 तौश्चालोहं निगदितं हितयं रसवेदिभिः ।  
 समिश्रलोहचितयं सौराश्रौतिवर्तकाः ।  
 एतेऽष्टौ धातवो ज्ञेया लोहान्येवं भवति हि ॥

अथ रसकाशुलाः ।  
 हिविधो रसकः प्रोक्तः कारबेहक-दुदूरः<sup>1</sup> ।  
 सत्त्वपाते परः प्रोक्तः प्रथमद्वौषधादिषु ॥  
 स तु<sup>2</sup> मेहहरवैव पित्तम्भेदविनाशनः ।  
 रस्त्रनः पारदस्त्राद्य नेत्ररोमस्त्रयापहः<sup>3</sup> ॥

(1) The text reads कानो वहवदुदूरः, which appears to be incorrect.

(2) The text reads सत्त्व, which seems to be incorrect.

(3) The second hemistich is wanting in the text.

We have adopted the reading of रसरमस्त्रुचय.

पारदो रसकबैव देहलोहकरावभौ ।  
 नागाङ्गुनेन कथितौ सिंहौ चेष्टौ रसावुभौ ॥  
 ज्ञतौ येनान्मिसहनौ सूतखर्परकौ श्वभौ ।  
 तेन स्वर्णमयौ सिंहरज्जिता<sup>1</sup> च न संशयः ॥  
 रसको द्रावितः सम्यक् निक्षिप्तो रसपूरके ।  
 निर्मलत्वमवाप्नोति सप्तवारं निमञ्जितः<sup>2</sup> ॥  
 काञ्जिके वाय तक्रे वा न्टमूढे<sup>3</sup> मेषमूढके ।  
 द्रावितं खालितं<sup>4</sup> सम्यक् खर्परं परिशुद्धति ।  
 खर्परं रेचितं शुद्धं स्थापितं नरमूढके ।  
 रज्जयेचासमेकं हि ताम्भं स्वर्णप्रभं वरम् ॥

- (1) The text reads सिंहौ राजिता, which is not accurate.
- (2) The text reads निमञ्जितं, which is incorrect.
- (3) The text has only मूढे, which mars the metre.
- (4) द्राविते खालिते is the reading of the text; which is evidently an error.

वचाहरिद्राचिकला-गृहवूमैः ससैन्धवैः ।  
 भज्ञातकैष्टुष्णैश्च आरैरान्नेश्च महितम्<sup>1</sup> ॥  
 पादांशसंयुतैर्मूषां हृत्ताकफलसन्निभाम् ।  
 निरुध्य शोषयित्वा च मूषामुखोपरि न्यसेत् ।  
 प्रधाते खुपंरे ज्वाला सिता नीला भवेद्यदि ।  
 लोहसंदंशके मूषां हृत्वा छाला द्वाधोमुखीम् ।  
 भूम्यामाढालयेत् सत्त्वं यथानालं न भज्यते ।  
 तदा सौसोपम<sup>2</sup> सत्त्वं पतत्वेव न संशयः ॥  
 अनेनैव प्रकारेण वारचयक्षते सति ।  
 विनिःसरेत् सर्वसत्त्वं सहिंगु(?)गुरुणोदितम् ॥  
 अथ सौराङ्गोगुणाः ।  
 सौराङ्गेश्च सञ्ज्ञाता खनिजाः<sup>3</sup> तुवरी मता ।  
 या लेपिता खेतवस्त्रे रङ्गबन्धकरी हि सा ॥

(1) The text reads वर्जितं, which seems to be incorrect.

(2) रसरबसमुख्य says वर्जाभं. See Chap. II. Verse 161.]

(3) The text reads खनिता, which is incorrect.

फुलिका खटिका<sup>1</sup> तहत् द्विपकारा प्रशस्तते ।  
 किञ्चित् पौता च सुखिन्धा गरदोषविनाशिनी ॥  
 श्वेतवर्णा परा साक्षा फुलिका लोहमारणी ।  
 कषाया मधुरा काष्ठी कटुका विषनाशिनी ।  
 ब्रह्मन्त्री कफहा चैव नेत्रव्यापचिदोषहा ॥  
 कण्ठरोगहरा सा तु पारदे वोषजारणी ।  
 धात्वान्ते तुवरी चिसा शुद्धति चिदिनेन वै ॥  
 चारेराज्ञेषु महिता भाता सर्वं विमुच्छति ।  
 तत् सर्वं धातुवादार्थं धीषधे नोपपत्तते ॥

अथ पुटानि लिख्यन्ते ।  
 भूम्यां वै खन्यते गर्जं द्विहस्तं चतुरस्तकम् ।  
 छग्येन सहस्रेषु पूरयेत्तदनन्तरम् ।  
 औषधं धारयेत्याध्ये तदाच्छाय वनोपलैः ।  
 सहस्रार्थेन वै सम्यग्तद्विं प्रज्वालयेत्ततः ॥  
 महापुटमिदं प्रोत्तं यन्यकारेण निर्णितम् ।  
 इति महापुटम् ॥

(1) रसराजसुवद says कटकी फुलिका.

एकहस्तप्रमाणं हि चतुरस्तं च गत्तकम् ।  
 वनोपलसहस्रेण गत्तमध्यं च पूरितम् ॥  
 मूषिकां चौषधेनाथ पूरितां तां हु मुद्रयेत् ।  
 गत्तमध्ये निधायाथ गरिष्ठानि<sup>1</sup> च निश्चिपेत् ॥  
 जर्हानिं ज्वालयेत् सम्यक् सोऽयं गजपुटो भवेत् ॥  
 इति गजपुटः ॥

उपलं पिट्टकं छाण्डुत्पलस्त्वा गरिष्ठकम् ।  
 कुण्डोपलसारौ च तच्चरा<sup>2</sup> कुण्डाभिधाः ॥  
 अरद्धिमादे कुण्डे च वाराहपुटसुच्चते<sup>3</sup> ।  
 इति वाराहपुटः ॥

वितस्त्विद्यमानेन गत्तं चेष्टतुरस्तकम्<sup>4</sup>  
 कुकुटास्यं पुटं विद्यादीषधानाश्च साधनम् ।  
 इति कुकुटपुटः ॥

(1) रसरबसमुच्चय reads निरिष्ठानि.

(2) रसरबसमुच्चय reads वराटी.

(3) The text reads अभिमादेष इच्छे च वाराहपुटमध्यवः, which seems to be incorrect.

(4) The text reads वसे कुर्बाचतुरस्तकं, which mars the metre.

इग्नैरष्टभिः सम्यक् कपोतपुटसुचते ।  
 इति कपोतपुटः ॥

तुष्वर्वा गोवरैर्वापि रसभस्मप्रसाधनम् ।  
 माणिकाद्यमानेन गोवरं पुटसुचते ।  
 इति गोवरपुटः ॥

मृदभाष्टे तु प्रपूर्येव मध्ये द्रव्यं तु विन्यसेत् ।  
 अधस्ताल्ज्वालयेदग्निं मृदभाष्टपुटसुचते ।  
 इति (मृद)भाष्टपुटः ॥

गते तु बालुकापूर्णे मध्ये द्रव्यं तु विन्यसेत् ।  
 उपरिष्ठादधस्ताच्च वक्षिं कुर्यात् प्रयत्नतः ।  
 तद्बालुकापुटं सम्यगुचते शास्त्रकोविदेः ।  
 इति बालुकापुटः ॥

भूषिकां भूमिमध्ये तु स्थापितां द्वाङ्गुलादधः ।  
 उपरिष्ठात् पुटं दद्यात्<sup>1</sup> तत् पुटं भूधराभिधम् ।  
 इति भूधरापुटः ॥

(1) The text reads दद्या, which is incorrect.

गोवर्वा तुषेवीपि माचाकर्षमितैः पुटम् ।  
 यद्य तज्जावकास्यं स्वामृद्रव्यस्य साधने ॥  
 इति सावकापुटः ॥

इति श्रीपद्मनाभस्तु श्रीयशोधरविरचिते  
 रसप्रकाशसुधाकरे दशमोऽध्यायः ।

अथातः संप्रवक्ष्यामि धातूनां कौतुकं परम् ।  
 स्वानुभूतं मया किञ्चित् त्रुतं यच्छास्तः खलु ।  
 तदहं कथयिष्यामि यत् क्षत्वा ना सुखो भवेत् ॥  
 रसकं दरदं ताप्यं गगनं कुनटोसमम् ।  
 रक्तमुहीपयोभिष्य मर्हयेहिनसमकम् ॥  
 जलयन्देण वै पाण्यं चतुर्विंशतियामकम् ।  
 तेन वेष्यं द्रुतं ताम्रं तारं वा नागमेव वा ॥  
 सह(शत)वेष्टी तु तत्कर्त्तो जायते नाथं संशयः ॥  
 एषभागस्तथा सूतो वज्रवक्षगाय मर्हितः ।  
 सहे विनिंश्याच रवे पश्चभागसमन्विते ।  
 वेदयस्या च रागिष्या पीतकर्त्तं प्रजायते ॥

बोड्यांशेन दातव्यं द्रुते ताज्जे सुशोभने ।  
 जायते प्रवरं हेम शुद्ध वर्णवतुर्दयम् ॥  
 इति हेमक्षिया ।

स्वर्णमाच्चिकं संखोद्य काञ्जिके दिवसवयम् ।  
 चर्मरंग्या(गा)रसेनैव मर्हयेह्नसप्तकम् ।  
 जलेन धीतं तावच यावदेमनिर्भं भवेत् ।  
 दरटं रसदेशीयं<sup>1</sup> गोमूवेषेव स्वेदयेत् ।  
 दोखायन्तेऽङ्गि<sup>2</sup> चत्वारि पश्चात्तुइतमो भवेत् ।  
 मगःशिला पश्चनिभा रक्ता चेव सुशोभना ।  
 स्वेदिता सुनिषुप्तस्य रसेनैव तु दोखया ।  
 याममर्द्दमिता शुद्धा सर्वकाञ्जेषु योजयेत् ॥  
 नवसारसाथा सूतः शोषितोऽन्तिमति स्वसे ।  
 समभागानि सर्वांचि मर्हयेचिन्दुकारचेः ।  
 मातुलुहरसेनैव कुमारोहुरसेन वा ।  
 सूर्यातपे विमर्होऽस्त्री पाचितो अस्यव्यक्ते ।  
 दिनानि ब्रौचि तौद्रान्ती द्वार्यात्सद्वतारवेत् ।

- (1) The text reads रुद्रेशी, which is incorrect.  
 (2) अङ्गि [चत्वारि] is grammatically incorrect.

शतांशं वेधयेत्तारं शुद्धैम प्रजायते ।  
 जलभेदो यदा न स्थानात्र कार्या विचारणा ॥  
 शिलया मारितं नागं कुमार्याः स्वरसेन तु ।  
 पुटादश्योगेन नागभक्ष प्रजायते ॥  
 शतसंख्यानि वै कुर्यात् पुटान्येवं शरावके ।  
 कुमार्याः स्वरसेनैव भावयेहिनसप्तकम् ॥  
 पूर्ववत् पुटनं कार्यं शतसंख्यामितं तथा ।  
 सूतगन्धशिलादहुसमं चेत्रागभक्षकम् ।  
 त्रिंशहनोपलैर्दद्यात् पुटं वाराहसंज्ञकम् ॥  
 अनेन विधिना सम्यक् शतसंख्यानि दापयेत् ।  
 पुटान्येवं कृते चौणि शतानि हादशाधिकम् ॥  
 पश्चादृदे काषमये कूपे हात्रिंश्यामकम् ।  
 बालुकाम्लं प्रदद्यात् स्वाङ्गशीतं समुद्दैत् ॥  
 तसम्भक्ष यहीतव्यं वेधयेत्तारशुद्धके ।  
 शुद्धैम भवेत्तेन नात्र कार्या विचारणा ॥  
 हृष्टप्रत्यययोगोऽयं कथितो नात्र संशयः ॥

# Extracts from RASACHINTAMANI.

मदनाम्नदेवसूरिविरचितात् रसचिन्तामणे:  
उद्भृताः स्नोकाः ।

सैन्धवं तोरिकां सूतं कासौषं सङ्कुचद्रवैः ।  
विष्टय खस्तभाष्टसं सर्वश्वसं दिनपयम् ॥ ७६ ॥  
इस्तिकायां तदारोय काष्ठवह्निर्धौयते ।  
दिनप्रयैप्यतिक्रान्ते भस्त्र श्वेततरं भवेत् ॥ ७७ ॥

\* \* \* \* \*

इति वयोदय भस्त्रस्तः ।

खर्परो द्वादशांशः चात् शिखिग्रीवं च तुत्यकं ।  
षड्गुणं मालिकं नेत्रभागं यात्तं मनःशिला<sup>१</sup> ।  
भागद्रवयमिदं यात्तं शोभनागतकर्तृः<sup>२</sup> ॥ ३८ ॥

(1) शोभनागतमाणा मनःशिला is the correct reading as stated in the margin of the text.

(2) बबी भागा चपि यात्ताः शोभना गतकर्तराः is the correct reading as stated in the margin of the text.

गंधकवयमेवास्ते काष्ठमाच्चौरसैभूङ्गं ।  
 दिनसप्ताह कर्त्तव्या भावना महेन्म क्रमात् ॥ ३८ ॥

अधोमुखेन यन्त्रेण तेन निःसारयेद्बुधः ।  
 सत्त्वं तद्रसकस्याथ हृष्टं कार्यकरं परं ॥ ४० ॥

अवश्यं तहृष्टं सत्त्वं निर्धमं कर्मसाधनं ॥

इति रसकसत्त्वपातनं ।

विवारं गन्धकहतं ताम्रहेमहयवयं ।  
 सत्त्वं तालस्य मासेकं योजयेत् सर्वकामदं ॥ ४१ ॥

अभ्यवण्णं भवेष्टेमं ताम्रगंधकमारितं ।  
 एतयोर्दीर्यिते रथ्यं जायते कांचनं शुभं ॥ ४४ ॥

इति श्रीमद्भागवतदेवविरचिते रसचिंतामणी  
 हेमोकरणप्रयोगः ॥

पारदं सौसकं गंधं कुनटौ तच्छतुष्टयं ॥ ॥  
 बौजपूरामसा पिष्टा बाढ़ं दिनचतुष्टयं ॥ १०८ ॥

अथ सूक्ष्माणि पश्चाणि तेन तारस्य लैपयेत् ।  
 बौजपूरसेनैतत् त्वयिमात्रान्वितापितं ॥ १०९ ॥

एकाधिका भवत्यत्र भावनाशास्त्र विंशति ।  
 विशोषावर्त्तिं तारं भवेत्तारज्ज्ञ कांचनं ॥ ११० ॥  
 इति चिंतामणी हेमीकरणप्रयोगः ॥

हेमभागहयं तारं तथा ताम्बं चतुष्टयं ।  
 एकतः क्रियते पचमतिसूक्ष्मं निरामयं ॥ १११ ॥  
 अंबौरनीरसंपिण्ठं स्फर्परस्याष्टटंकणं ।  
 तेन तान्धय पद्माणि लेपनीयानि वै बहु ॥ ११२ ॥  
 आवर्तते पुनर्दस्ता मूषके गलितानि च ।  
 तदा तानि भवत्यत्र हेमरूपाणि नान्धया ॥ ११३ ॥  
 इति हेमीकरणप्रयोगः ॥

एकभागो भवेदारः तारं भागहयं भवेत् ।  
 वेदभागं भवेत्तौर्ज्ज्ञं सत्वं सत्वाज्ज्ञ वै दश ।  
 बंगभागं भवेत्प्रत्यक्षं सर्वमेकद्रव कारयेत् ॥ १०८ ॥  
 टंकचेन पुनः आतं पञ्चं छत्वाज्ज्ञ वल्लुनं ।  
 वेत्ताच्यमिदं आतं तत्त्वमध्ये निवेशयेत् ॥ ११० ॥  
 एवं तारं भवेत्तूनं यतोषाच्चममापये ।  
 इति तारोत्त्वाद्वाहं ॥

तुत्यकं पिष्टते खल्ले चिफलाहिंगुटंकणैः ।  
 मध्वाज्यमित्रितं धातं सत्वं पातयते ध्रवं ॥ ६८ ॥  
 इति तुत्यकसत्वपातनं ॥

खर्परः खेद्यते पूर्वं कौलयेन जलेन च ।  
 वटारोहजलेनापि पणेचूर्णेन शोभनः ॥ ६५ ॥  
 गुडटंकणसंमिश्रचिफलाक्वाथमर्दितः ।  
 मृद्यये कूपके क्षत्वा धात्यमानो भृशं च सः ॥ ६६ ॥  
 खेतधूमोद्गमे जाते तत उत्थाप्य कूपकं ।  
 सावधानं करेणैव भूमौ तं चाध आनयेत् ॥ ६७ ॥  
 पुनस धात्यते कूपः तथाजातं च तं पुनः ।  
 कूपकं च पुनर्भूमौ तथा तं नामयेत् पुनः ॥ ६८ ॥  
 सत्वं खर्परकस्यैतत् नागरूपं पतत्यधः ॥ ६९ ॥  
 इति खर्परसत्वपातनं ॥

# Extracts from RASAKALPA.

**रुद्रयामलान्तर्वतात् रसकाल्पादुहृताः  
श्वोकाः ।**

श्विं नत्वा रसाधीशं चण्डिकाचरणं तथा ।  
क्रियते<sup>१</sup> रसकाल्पोऽयं रसज्ञानविशारदः<sup>२</sup> ॥ १ ॥

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॥ अथ परीक्षा ॥

अतेजा अगुहः शुभ्रो लोहडा<sup>(१)</sup>चचलो रसः<sup>३</sup> ।  
यदा<sup>४</sup> नावार्त्येदङ्गो नोहैं गच्छेत्तदा भृतः ॥ ४० ॥

(1) The text reads करीमि, which is grammatically incorrect.

(2) The reading in the text is विशारदम्, which is incorrect.

(3) The text reads रस, which is incorrect.

(4) The text reads बदामावर्त्येत्, which is not correct.

दन्ते शृङ्खे मणी वेष्टौ रचयेत् साधितं रसम् ॥ ४२ ॥  
 इति श्रीब्रह्मायामसे रससंकेतकं नाम  
 प्रथमोऽनासः ।

हेमरुप्याकंवज्ञाहि<sup>१</sup>लौहा लौहाः<sup>२</sup> बड़ोरिताः ।  
 अद्विमा इमे देवां वर्त्ताद्याः स्युस्तु<sup>३</sup> क्विमाः ॥ १ ॥

सन्तो बद्धाद्वलिपुटो शुभान् विज्ञापयाम्यहम् ।  
 छपासुधारसयुता हृष्टिर्ग्रन्थे प्रदीयताम् ॥  
 महारसाः स्युस्ताचादावष्टौ पारदहिङ्गुले ।  
 वैष्णवं शस्त्रकं शैलं चपलं रसकोऽमलम् ।

(महारसाः)

(1) The text reads वज्ञाहि:, which is grammatically incorrect.

(2) लौहोहा is the reading of the text, which seems to be incorrect.

(3) The text reads रेताजांश्चासुक्तिमा, which is palpably an error.

अभ्यकं तुत्यकं कान्तं राजावस्तमयाच्छनम् ।  
वजूं वेक्रान्तकं चेव टह्यणं च रसा बहु ॥

(रसः)

गन्धकं तालकशिले चितिखेचरगैरिकाः ।  
इत्यादयशोपरसाः सर्वाचार्येऽहदीरिताः ॥

(उपरसाः)

सितासिताद्यणं पीतं गन्धकं तच्चतुर्विधम् ॥  
तालकं हिप्रकारं स्यात् गोदन्तः पाटलच्छविः<sup>1</sup> ॥  
रक्ता पीता शिला देघा पूर्वा चेष्ठोत्तराधमा<sup>2</sup> ॥  
बहुप्रकारा सौराद्वी कासीसं चिविधं मतम्<sup>3</sup> ॥  
कासीसं पुष्पकासौसं झीरकासौसमित्यथ ॥  
गैरिको हिविधः प्रोक्तः सौवर्णी लोहितस्तथा ॥

(1) The text reads *पाटलाच्छवि*, which seems to be incorrect.

(2) पूर्वा चेष्ठोत्तराधमा is the reading of the text, which is incorrect.

(3) The text reads कासीसचिविष्ठो नक्तः, which is incorrect as it is mentioned neuter in the next line.

कङ्कुषादौन्<sup>1</sup> रसान् केचिदांचार्या वर्णयन्ति वै ।  
अत्माभिरिह तदोक्तं सुनिमार्गानुसारिभिः ॥

इत्येष प्रोदितो मार्गो रसशोधनकर्मणि ।  
स्वच्छन्दभैरवाद्युक्तो गोविन्दादिसमाप्तः<sup>2</sup> ॥

लवणं चूलिकोडूतं गम्भकेन समन्वितम् ।  
सर्वाङ्गदस्य<sup>3</sup> चित्रादैँ भूलभस्मप्रगालितम् ॥  
गोभूचेण शतं भाव्यं तद्रसे जारयेत् शनौ<sup>4</sup> ।  
तस्य संपर्कंतः सूतो रात्रसो भवति ध्रुवम् ॥

(I) The text reads कंकुषादौन्, which is an error of the scribe.

(2) The text reads समादितः, which is incorrect.

(3) The text reads सर्वांगदस्य, which seems to be incorrect.

(4) शनिः, as given in the text, is grammatically incorrect.

एतदेव विष्ट दद्यात् सर्वंदा हेमजारणे<sup>१</sup> ।

मुखं संजायते तेन जोर्यते च<sup>२</sup> विनिश्चितम् ॥

इति श्रीरुद्रयामसे रसकल्पे उमामहेश्वरसंवादे

रमशोधनप्रकारः ॥

इति संधानयोगीत्यं जारणेऽतिगुणावदः ॥

प्रकाशितः संप्रदायक्रमप्राप्तः शिवोदितः ॥

इति श्रीरुद्रयामसे रसकल्पे उमामहेश्वरसंवादे

रसाधिकरणे<sup>३</sup> नाम हितीयोऽनाप्तः ॥

महारसानां सर्वेषां रसानां शुद्धिरुचते ।

तथैवोपरसानास्त्र शास्त्रहृष्टेन वर्तना ॥ १ ॥

कदलौपचञ्जीरैः मात्स्त्रैकं भावयेत् शतम्<sup>४</sup> ।

गन्धवं तैलमध्वाण्य-पक्षमेकं दिनदयम् ॥

- 
- (1) The text reads हेमजारणौ, which is not correct.
  - (2) The text reads न, which appears to be an error.
  - (3) The text reads रसाधिकारिता, which is incorrect.
  - (4) The text reads शब्दं, which is senseless.

तत्तात्पं वज्रमूषायाः<sup>1</sup> पक्षायां निचिपेत्तः ।  
 लोहसन्धानकरणं तत्समं तच निष्पचेत् ॥  
 दृढां प्रकल्पयेत्पूषाः<sup>2</sup> कोष्ठिके<sup>3</sup> विनिवेशयेत् ।  
 अङ्गारैः स्वदिरोग्नौतैः धमेदभस्ताहयेन वै ॥  
 वक्रनालयुजा सख्यं ताप्यस्य पतति भ्रुवम् ।  
 शुक्रदीप्तिः सशब्दस्त्र<sup>4</sup> यदा वैश्वानरो भवेत् ।  
 तदा सख्यं तु पतितं जानीयाकाम्यथा क्षाचित् ॥

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रसकं स्वेदयेदादौ<sup>5</sup> पटुचूर्णकातं दुधः ।  
 चतुर्गुणेन वस्त्रेण दृढं वज्रा च डोलिकाम् ॥

(1) तत्तात्पं वज्रमूषा is the reading of the text, which appears to be incorrect.

(2) The text प्रकल्पयेत्पूषाः is evidently incorrect.

(3) कोष्ठिकानि निवेशयेत् is the reading of the text, which has no meaning at all.

(4) The text reads सशब्दस्त्र, which is grammatically incorrect.

(5) रसकांस्वेदादौ is the reading of the text, which seems to be incorrect.

छत्वा भाष्टे च सजले<sup>1</sup> स्तेदयेकासपचकम् ।  
 उहृत्य पश्चाद्रसकं स्त्रामधे<sup>2</sup> विचूर्णयेत् ॥  
 पादीशान् मालतीजातं सगुडं जीर्णगुच्छकम् ।  
 गृहधूमं रेवकीं च निशामं कुलजीरकान्<sup>3</sup> ॥  
 तत् सर्वं चर्णितं छत्वा गोपयचकविभावितम् ।  
 छत्वा तद्वटिकाः पश्चात् छायायां शोषयेत्ततः ॥  
 कोष्ठगेनाग्निना<sup>4</sup> पश्चात्तद्भस्त्राद्याग्निले ।  
 सत्वं पतत्यसंदेहं स्थिररक्तं दृढं बहु ॥  
 एकमासं हिमासं वा रसकं स्तेदितं यदि ।  
 न धातव्यं तत्र कोष्ठे धमित्तत् नालभूषया ॥

— —

इति सम्पादितो मार्गो द्रुतीनां पातने स्फुटः ।  
 साक्षादगुभैर्द्धौ न श्रुतो गुरुदर्शितः ॥

- (1) छत्वा भाष्टे सजले .is the reading of the text, which is incorrect.
- (2) The text reads स्त्रामधे.
- (3) The text has जीरकां, which is grammatically incorrect.
- (4) The text reads कोष्ठगेनाग्निना, which is not correct.

लोकानामुपकाराय एतत् सर्वं निवेदितम् ।  
 सर्वेषां चैव लोहानां द्रावणं परिकीर्तितम् ॥  
 इति श्रीरुद्रयामले रसकाले उमामहेश्वरसंवादे  
 सर्वलोहद्रुतिपातनाधिकारः समाप्तः<sup>1</sup> ॥

## Extracts from RASARAJALAKSHMI.

विष्णु देवविरचितायाः रसराजलक्ष्मा:

प्रारम्भः—

यस्येच्छाहुरवस्त्रौ सुकुलिता नानाकलाकौतुकैः  
 चातुर्यैङ्कविलोलपङ्गववतौ कौर्त्तिप्रसूनप्रसूः ।

(1) समाप्तं यत्तम् is the reading of the text, which is not correct.

संनिर्बापयति व्यरदयमहो च्छायाकशापैर्मृच्छा  
सोऽयं पातु विचारमूर्तिरचिह्नं काशापखौढं अगत् ॥१॥

अयति दुरितसर्पस्त्रोऽमंक्रोद्यदप्तः  
प्रबलगदविनाशः सेविविष्वस्त्रनाशः ।  
शिव इव विज(बीज ?)मंत्रः संहितायोगमंत्रः  
त्रिपुरइरतनूजस्त्रेत्रसः कायपुंजः ॥ २ ॥

इति श्रीपण्डितमहादेवतनयश्चैविष्णुदेवविरचितायां  
रसराजलमध्यासुक्षासः प्रथमः ॥

इद्देवं रससागरं शिवक्षतं श्रीकाकचण्डेश्वरौ-  
तम्भं सूतमहोदधिं रससुधाश्चोधिं भवानीमतम् ।  
व्याहिं सुन्नुतसूचमीश्चाद्यदयं सच्छंदशत्रयागमं  
श्रीदामोदरवासुदेवभगवद्गोविन्दनागार्जनाम् ॥  
प्रथमः उक्षासः ।

सच्छंदशत्रयागमसारभूतः  
ससुषृतो विष्णुभिषम्बरेत् ॥ ११० ॥  
द्वितीयः उक्षासः ।

आलोक्य सुनुतं हन्दहारोत्तरवादिकान् ।

आव्रेय वामटं सिषसारं दामोदरं गुरुम् ॥

द्वौयः उषासः १०

\* Foll. 1—43. Linn. 10. Rasarájalakshmís, de medicamentis metallorum et fossilium ope conficiendis liber, a Rámes'vara (bhatta), Vishnus filio, compositus. Incipit : आनंदेकरसे विकल्पक्लग्ननिमुक्तबीचार्यकिं प्रागंवादविसंवत्ति-  
व्यपगते etc. ॥ १ ॥ स्त्रिमुखीमंयनमंथनेन (1. स्त्रीमुखी०) sphurad  
Rasámbhodhi-gabbíragarbhát । s'rí-Vishnundevi (o deví)  
labhate prayatnát s'rí Vishnuvatsád Rasarájalakshmím  
॥ २ ॥ Drishtyemam Rasaságaram, S'ivakritam s'rí-Karka-  
chandes'varistántram, Sútamahodadhim, Rasasadhám-  
bhodhim, Bhavánímatam, Vyádi[m], Sus'rutasútram,  
Ís'ahridayam, Svachchhandas'aktyágamam, s'rí-Dámoda-  
ra-Vásudeva-Bhagavad-Govinda-Nágárjunán ॥ ३ ॥ आनंद-  
मानंदकरं प्रसन्नं आनसन्नं विजमादयुक्तम् । योगीद्वीयं भवतीगवैयं  
श्रीमद्गुरुं निष्ठमहं नमामि ॥ ४ ॥

महारसाः सुक्षमादावटी पारदहिंगुणे ।

वेष्टकं सुखकं शैलं चपलं इसकोमलम् ॥ ५ ॥

चमकं तुहकं (tutthakam) कानं राजावर्तमालाकमं ।

वक्षकोक्तातकं (o vaikrántakam) चेति टक्कं च रसान्वितः ॥ ६ ॥

ताक्कं वेष्टकविष्णि विष्णिवर्तमेरिकाः ।

रसादवशीपरसाः पूर्णचार्येहदीरिताः ॥ ७ ॥

Aufreicht's "Catalogus," p. 321, No. 761.

Colophon at the end of the Rasarájalakshmi—

राजन् (सग्न)शार्वरिवस्त्राद्यदिवसे वारे हिमांशोरिदं  
चंचद्भूतलपत्तने विजयिनि श्रीबुक्कपृष्ठवीपतेः ।  
शास्त्रं वैद्यकसाररूपमकरोत् श्रीविष्णुदेवः कविः  
वाग्देवीचरणारविंदमकरंदामोदसौरस्त्रवाक् ॥

## Extracts from **RASANAKSHATRAMALIKA**

मथनसिंहविरचितायाः रसनक्षत्रमालिकायाः  
उच्चृताः श्लोकाः ।

चतुर्थतुःशंखकपर्हिकानां  
सतक्षत्रम्बीरविमहितानाम् ।  
आफेनमाञ्जीकविषद्यानां  
पलं पलं दग्धिप्रकाशनितानाम् ॥ २५ ॥

यतभक्तगन्धसुता हितयं वक्ष्य शुद्धतौद्वस्य ।  
 दग्धा मृगस्य शृङ्खं विगुणं दत्त्वा रसार्द्धविषम् ॥ १२३ ॥  
 चित्तकशोतशिवाहृषदशमूलदिवनदविल्पगिरैः ।  
 कालहत्तारविकृतकैः प्रत्येकं भावनवितयम् ॥ १२४ ॥  
 दत्त्वा सुसिद्धमात्रो मारिचधूपेन धूपितः सम्यक् ।  
 स्वच्छन्दभैरवाख्यो रसः समस्तामयध्वंसो ॥ १२५ ॥  
 चिकट्टकरसेन युक्तो विशेषतः सक्रियातहरः ।  
 अहणिगदामयशूलब्रणविद्विषातगुरुणजयी ॥ १२६ ॥  
 इति स्वच्छन्दभैरवो रसः ॥\*

इयं मालविभूपालभिषजा भिषजां मता ।  
 कृता मथनसिंहेन रसनद्वमालिका ॥ १४२ ॥

इति रसनद्वमालिका समाप्ता ॥ अस्ति  
 संवत् १५५७ आश्विन ज्येष्ठ ५ सोमे ।

\* The स्वच्छन्दभैरव रस mentioned in the रसनद्वमालिका is quite distinct from that, which is stated in the रसेन्द्रचित्कारिणी. Neither has it any analogy with what is described in the रसरबद्धमुख्य.

# Extracts from RASARATNAKAR

**नित्यनाथविरचितात् रसरत्नाकरात्**  
**उद्गुताः स्तोकाः ।**

यदुक्तं शशुना पूर्वं रसखण्डे रसार्णवे ।  
 रसस्य वस्त्रनार्थं च दीपिकारसमङ्गले ।  
 व्याधितानां हितार्थाय प्रोक्तं नागार्जुनेन यत् ।  
 उक्तं चर्चटिसिद्धेन<sup>1</sup> स्तंगवेद्यकपालिके ।  
 अनेकरसग्राहेषु संहितासागमेषु च ।  
 यदुक्तं वाभट्टे तत्त्वे चन्द्रुते वैद्यसागरे ।  
 अन्येष बहुभिः सिद्धैः यदुक्तस्त विलोक्त तत् ।  
 तत्त्वं यद्यदसाध्यं साद्यद्यद्यदुक्तं भमौषधम् ।  
 तत्त्वं सर्वं परित्वच्य सारभूतं समुच्चृतम् ॥  
 क्वचिच्छाखे क्लिधा नास्ति क्रमवापि न च क्वचित् ।

(1) चर्चटिसिद्धेन is the reading in the Sanskrit college MS.

मात्रायुक्तिः क्वचिमास्ति सम्प्रदायो न च क्वचित् ।  
 तेन सिद्धिर्न तद्रास्ति रसे वायु रसायने ॥  
 वैक्षे वादे प्रयोगे च तत्काद्यन्तो मया छतः ॥  
 यद्यद्यद्गुरुमुखाज्ञातं स्तानुभूतस्त यथा ।  
 तत्त्वोक्तितार्थाय प्रकटीक्रियतेऽधुना ॥  
 प्रथमोपदेशे ।

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इति श्रीपार्वतोपचानित्यनाथसिद्धविरचिते रसरात्राकरे  
 रसखण्डे रसपीठिका नामं प्रथमोपदेशः ।

परीक्षा मारिते सृते कर्त्तव्या च यथोदिता ।  
 अघसुषाम्बिना तस्मी श्लोणस्तिष्ठते यदा ।  
 तदा भस्म विजानौयाज्ञुह्नग्रां यामं निरोक्षयेत् ॥  
 द्वितीयोपदेशे ।

दन्ते शुक्रेऽथवा वंशे रक्षयेत् साधितं रसम् ॥  
 चतुर्थोपदेशे ।

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अथातः शुक्रसूतस्य मूर्च्छनाविधिहच्चते ।  
 मेघनादावचाहिङ्ग्युरण्मईयेद्रसम् ।

नष्टपिष्ठनु तदगोलं हिङ्गुना वेष्टयेहाहिः ।  
 पचेहवस्यव्यवस्थं दिनैकं चक्रवङ्गिना ॥  
 अर्द्धसमं समादाय दृढं वस्त्रेण वस्त्रयेत् ।  
 अर्द्धाधी गन्धकं तुस्यं दत्त्वा सोमानसे पचेत् ॥  
 जीर्णे गन्धे पुनर्देयं घडभिर्वारैः समं समम् ।  
 घडगुणे गन्धके जीर्णे मूर्च्छितो रोगहा भवेत् ॥  
 चतुर्थोपदेशे ।

## Extracts from DHATURATNAMALA.

### धातुरत्नमालायाः

**प्रारम्भः—**

प्रथम्य विततीं शशिं चिरूक्ष्यत्पत्तिकारिणीं ।  
 धातुरां रत्नमालायामभिधायं करोम्यहं ॥ १ ॥  
 ब्रह्मविच्छुद्धरायान् ये मर्त्ता आयंति नित्यगः ।  
 चानदानप्रदानाय सा मे विश्वेश्वरी मता ॥ २ ॥

अथ धातुनां रद्धमालां वस्त्रामि ।  
 रौप्यं हेमं तथा ताम्रं नागं वर्ङं तथायसं ।  
 चुर्पंदात्रवक्त्रमौलं च प्रबालं तास्कं शिला ॥ ३ ॥  
 सुवर्णमाद्विकं सूतं हौरकं च ब्रवीम्यहं ।  
 सर्वधातृपधातूनां सूक्ष्मणं मारणं गुणं ॥ ४ ॥  
 अथ रौप्यमारणं ।  
 रौप्यं शुद्धं समादाय नागेन गुरु शोधयेत् ।  
 शुद्धे तारे पुनः पश्चात् सूक्ष्मपत्राणि कारयेत् ॥ ५ ॥  
 मिंचिर्चिरिचिद्राक्षाभिः शोधयेच पृथक् पृथक् ।  
 चालयेदुदकैः सार्वं तथा दुखेन शोधयेत् ॥ ६ ॥  
 गंधपारदयोरैकं किंचिहंगं च घर्षयेत् ।  
 द्राक्षाया द्रवसंयुक्तं तारपत्राणि शोधयेत् ॥ ७ ॥  
 चक्रयन्ते विनिश्चिप्य लेपयेद्रवस्त्रमृत्तिकां ।  
 चिपेद्गजपुटे गत्ते ज्वालयेद्बहुषानकान् ॥ ८ ॥  
 समाप्तिः—  
 अंथो वैद्यकनामायं रससिद्धांतसागरात् ।  
 धातुनां रद्धमाला च ततो बैष्यस्य हेतवे ॥ १७६ ॥

मरणेभ्यो भयवस्ता रोगप्रसादृश्च ये नराः ।  
 रद्धमाला छाता तेषां वैवानां च इताय वै ॥ १७७ ॥  
 इति श्रीवैद्यकशास्त्रे अस्मिन्नौद्गुमारसंहितायां  
 धातुरद्धमालायां समाप्तोऽयं प्रथमः ॥

The following is taken from Aufrecht's  
 "Catalogus"—No. 760.

Incipit :—प्रणम्य सारदां शक्तिं सृष्टेदसर्ति-  
 कारकां । धातूनां रद्धमालां च विकोधाय करोम्यहं  
 ॥ १ ॥ ब्रह्मविष्णुहरान् ध्यायेद्वाता ध्यायन्ति नित्यशः ।  
 तेषां वरप्रदानाच्च सा मयेवमुदौर्घते ॥ २ ॥ रूप्यं  
 हैम तथा ताम्रं नागं वंगं तथायसं । सुर्परं गगनं  
 प्रोक्तं प्रबालं तालकं शिला ॥ ३ ॥ मात्रिकं गंधकं  
 सूतं हीरकं च ब्रौम्यहं । सर्वधातूपधातूनां सूक्ष्मं  
 मारणं गणान् ॥ ४ ॥ रूप्यं शुद्धं समानीय नाग-  
 मूषा तु शोधयेत् । शुद्धे तारे पुनः पश्चात् सूक्ष्म-  
 पदाणि कारयेत् ॥ ५ ॥ निंदुचिंचिणीद्राजाभिः शोधनीय  
 पृथक् पृथक् । क्षालयेदुदकैः सार्वे तथा दुधेन  
 शोधयेत् ॥ ६ ॥ गंधकं पारदं रूप्यं किंचिद्वर्गं च

घर्षयेत् । द्राक्षारसेन संयुक्तं तारपदाणि सेपयेत्  
 ॥ ७ ॥ नक्तं यन्मे विनिश्चित्य सेपयेद्यवस्थमृतिकां ।  
 क्षेयं गजपुटे गर्जे व्याख्येत् अहोपलैः ॥ ८ ॥

In fine libelli disticha haec leguntur :  
 ग्रन्थो वैष्णव [क] नामायं Rasasiddhántaságarát ।  
 धातूनां रद्धमाला च क्षता वैष्णवसुहेतवे ॥ १ ॥  
 मरणेभ्यो भयदस्ता रोगशस्ताष्य ये नराः ।  
 रद्धमाला हि धातूनां क्षता तेषां हिताय वै ॥ २ ॥  
 Játýá Gurjarakhandas cha, Devadatto  
 hi dharmavit ।

Harer námábhidhánasya सुतस्तस्य भिषम्बरः ॥ १ ॥  
 संहितारसकर्माणि यस्य बुद्धिगरीयसी ।  
 तेन शास्त्रविधिज्ञेन क्षता रद्धस्य मालिका ॥ ४ ॥  
 इति देवदत्तक्षतवैष्णवकशास्त्रे धातुरद्धमाला ॥

# Extracts from RASAPRADIPA.

**रसप्रदीपादुदृताः श्लोकाः ।**

A—MS. from Alahabad.

B—MS. from Benares.

पथ शङ्कद्रावरसः ।

स्फटिका<sup>1</sup> नवसारसं सुसेता<sup>2</sup> च सुवर्चिका ।  
 पृथक् दशपलोक्यानं गन्धकः पिचुसंमितः<sup>3</sup> ॥  
 चूर्णयित्वा चिपेह्नाष्टे मृदये मृदविलेपिते<sup>4</sup> ।  
 तमुखं सुद्रयेत् सम्यक् मृदभाष्टेनापरेण च ॥  
 सरन्ध्रोदरकेणैव चुक्तग्नं तिर्यक् च धारयेत् ।  
 अधः प्रज्वालयेदङ्गिं हठाद्यावद्रसः स्तवेत् ॥

- (1) A reads स्फटिका, B. reads सुषटिका.
- (2) B reads सुसेता, which is not correct.
- (3) B reads पिसंमितुतः, which is not correct.
- (4) मृद्जि' लेपिते is the reading in B.

आदेकं सिवयद्यतात्<sup>१</sup> दक्षसर्वविवर्जितम् ।  
 गुरुमोदरयष्टात् प्रौहप्रविष्ट्यस्मादिश्चलगुत् ॥  
 बलपुष्टिप्रदो द्वेष भुजां च जारयेत् चक्षात् ।  
 विलोक्यतां महासोका रसमाहात्मग्रमद्गुतम् ।  
 कपर्दिकाश लोहानां यस्मिन् चिक्षा<sup>२</sup> गलन्ति हि ॥

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### फिरङ्गव्याधिः—

गैरिकं रसकार्पूरम् उपला च पूषक् पूषक् ।  
 टङ्गमार्चं विनिष्पित्वा<sup>३</sup> ताम्बूलोदलजौः रसैः ॥  
 वद्यतु हृशास्तेषां<sup>४</sup> कर्त्तव्या भिषगुप्तमैः<sup>५</sup> ।  
 सार्यं प्रातः समग्रौयात्<sup>६</sup> एवैकां दिनसप्तकम्<sup>७</sup> ॥

- (1) B reads वद्य.
- (2) A reads चिक्षा.
- (3) A reads विनिष्पित्वा.
- (4) A reads चतुर्दशेषां. B reads चतुर्दशेषां.
- (5) B reads भिषगीतमौ, which is incorrect.
- (6) B reads समग्रौयात्, which is incorrect.
- (7) दिनसप्तक an incorrect variant in B.

सष्टुता योलिका<sup>1</sup> देया भोजनार्थं निरवरम् ।  
फिरक्षुद्धाधिनाशय वटिकेयमनुस्तमा । \*

(1) गोधूमरीटिका इत्यर्थः-

\* The following is taken from बोगवरद्धिकी of Trimallabhatta, printed in Bombay in the S'aka year 1810.

यं बे सुसिद्धे उमरसमास्ये  
निधाय तृतस्य प्राप्ति पंच ।  
यज्ञोक्तस्त्राष्टुटिकेटिकाना  
सुगैरिकाना तुवरीयुतानाम् ॥ ५० ॥  
सुसेष्वाना समभाविकाना  
चूर्चाद्वं चोपरितो निदध्यात् ।  
चब्देन दद्वा महिषीभवेन  
पिण्डं रसीनस्य श्रावमेकन् ॥ ५१ ॥  
समक्षमेषाद् निधाय छंडे-  
राज्ञाद्येत् खर्षरजैर्विसंधि ।  
चूर्चंप्रलिप्तोदरमूर्च्चभाङ्गं  
संखाय संमुद्रा हडं सुचुडान् ॥ ५२ ॥  
प्रव्यालयेष्टिमधः क्रमेष्व  
संखाय यंचोपरि वस्त्रमाद्रम् ।  
वह्नि प्रदधाहितवटकमत  
तत् खाक्षीतं पारस्पर्यमुक्ता ॥ ५३ ॥

चन्द्रोदयास्थ रसवर्णने—

काशे ज्वासे फिरङ्गास्थे रोगे च प्रमो हितः ।

पथ उपायान्तरम्—

मुश्क्षा<sup>१</sup> कुलज्वाचैव<sup>२</sup> पारसीकयमानिका ।

भक्षातकफलं चापि पलामानं पृथक् पृथक् ।

तं द्वीषपुष्टीयसा प्रपिण्ठं

कूप्या विदध्याद्वसादरं च ।

कर्षप्रमाणं प्रहरवयं च

वक्षिं प्रदद्याद्य शीतलांगीम् ॥ ६४ ॥

गिक्षास्त कूपों सिकतास्थयंवा-

दास्कीव्य कठस्तममुं प्रगत्तात् ।

कपूरनामा रसनाथकोऽयं

वहः पुराणेच गुडेन भुक्तः ॥ ६५ ॥

निवर्ध्नभाजा सहजा च पथ-

शीखेन कुषामयनाशनः खात् ॥

फिरङ्गकरिकेश्वरी सकलकुहकालानखो-

इर्व्वलब्रह्मविनाशकद्रवजगर्भपूर्णिमपदः ।

सुवर्णसमवर्णङ्गाङ्गाङ्गाङ्गताङ्गतेजस्तरः

समक्षगदत्तस्तरो रसपतिः स कर्पूरकः ॥ ६६ ॥

इति कर्पूररसः वौद्धसर्वस्तात् ।

(1) B reads मुश्क्षा.

(2) B reads कुलज्वा चैव.

पश्चाद्विमानः सूतः स्यात् पट्पस्तोऽव गुडः चूतः ।  
 एकोऽन्त्यास्तिलं कुर्यात् वटीः कर्षप्रमाणतः ॥  
 खादेदेकां वटीं प्रातर्यावदारोऽवदर्घनम् ।  
 गोदभ्रात्यानुपानेन फिरङ्गामयनाशिनी<sup>१</sup> ॥  
 निम्बुकेन<sup>२</sup> विना नेत्र वर्जनौयमिहापरम् ॥

अथ उपायान्तरम्—

चोपचौनीभवं चूर्णं शाषमानं समाच्चिकम् ॥  
 फिरङ्गाव्याधिनाशाय भक्षयेत्तद्वणं त्वं जीत् ॥

(1) B reads फिरङ्गापविनाशिनी.

(2) B reads निम्बुकेन.

# Extracts from DHATUKRIYA or DHATUMANJARI.

रुद्रयामले धातुक्रिया धातुमञ्जरी वा । \*

श्रीगणेशाय नमः ।

पार्वत्युवाच ।

अथानन्तर<sup>१</sup> देवेश ब्रूहि धातुसुसंस्कृतिम्<sup>२</sup> ।  
येन विज्ञानमादेष साधयेदातुसंज्ञितः ॥ १ ॥

महादेव उवाच ।

धातुसुर्यविधः प्रोक्तः तुर्यसुर्ये खपदतः (?)<sup>३</sup> ।  
सत्त्वं रजस्तामवैष चतुर्थस्तु निरामयः ॥ २ ॥

\* The Ulwar MS. (A) reads धातुक्रिया, a part of the Rudrayámala ; but the Benares MS. (B) reads धातुमञ्जरी, a part of the same. The two MSS. are exactly the same in subject matter, differing only in name.

(1) A reads अथानन्तर, which is grammatically incorrect.

(2) A reads धातुमञ्जरी संस्कृति, which is grossly incorrect.

(3) The sense here is not clear.

राजसे राजसी सिद्धिसामसे तामसी सदा ।  
 सत्त्वसाधनं सात्त्विको आनीते<sup>1</sup> सर्वसाधनम् ॥ ३ ॥  
 पार्वत्याच ।  
 कथतां देवदेवेश सत्त्वं राजसतामसम् ।  
 अतीव गुणवत्<sup>2</sup> धातोः कार्यं लक्षणलक्षितम् ॥ ४ ॥  
 उपधातुक्रमेणैव तेषां लक्षणसाधनम् ।  
 विटकौ च मुदा युक्ता तेषां कर्मसु<sup>3</sup> साधनम् ॥ ५ ॥  
 उपकारो<sup>4</sup> गुणलक्षं नाना कार्यक्रिया शुभा ।  
 वियोगयोगचाच्छस्य वर्णमेदैसु मारणम् ॥ ६ ॥  
 समयं देवदेवेश विशेषा धातुक्रतुक्रियाः ।  
 येन विज्ञानमात्रेण साधयेत् गन्धकौः क्रियाः ॥ ७ ॥

- (1) A reads अनीते, which seems to be incorrect.
- (2) A has गुणवती, which appears to be incorrect.
- (3) कार्यं लक्षणलक्षिताः, a variant in A, which is not correct.
- (4) A reads erroneously कर्मस्.
- (5) A reads उपकार, which is grammatically incorrect.

महादेव उवाच ।

पृथिव्या गर्भमध्ये तु अनेका धातुस्त्रिष्ठति<sup>१</sup> ।  
 विस्तृता<sup>२</sup> कियत्कालेन धातुर्मानाविधोदिता<sup>३</sup> ॥८॥  
 गुणलक्षणसंयुक्तां<sup>४</sup> साम्रातं न स्मरामि ह<sup>५</sup> ।  
 कथं ते कथयिष्यामि<sup>६</sup> वद ब्रह्माण्डवासिनि ॥ ८ ॥  
 पाव्यत्युवाच ।  
 ये केचित् सर्व्यन्त<sup>७</sup> ईश व्यक्तं कथय साम्रातम् ।  
 भवतोऽनुश्वेषेण व साधनार्थस्त्रि<sup>८</sup> सिध्यति ॥ १० ॥

(1) अनेका धातु तिष्ठति, a variant in A, which treats the word धातु in the neuter as well as in the feminine genders.

- (2) A reads विस्तृता, which is not correct.
- (3) धातुर्मानाविधोदिता, an incorrect variant in A.
- (4) A reads संयुक्ता, which is grammatically incorrect.
- (5) A reads स्मरति ह, which is incorrect.
- (6) कथयामात्र is the incorrect reading in A.
- (7) A and B read स्मरते, which is grammatically incorrect.
- (8) स्मरता is the reading in A and B, which is not correct.
- (9) साधनामर्थ is the incorrect reading in A and B.

**महादेव उवाच ।**

शृणु देवि प्रवच्यामि धातुं नानाविधस्तिम् ।  
 गुणलक्षणसंयुक्तां यथा दुष्टिः<sup>1</sup> कथिष्यति ॥ ११ ॥  
 मुख्यप्राधान्यता<sup>2</sup> एते रक्तलोहकर्ताम्बकैः ।  
 रजतेनैदृ<sup>3</sup> संयुक्ता धातोहत्तमता सदा ॥ १२ ॥  
 मध्यमा सत्त्वजा धातुः<sup>4</sup> नीचा च वपुसौसयोः ।  
 संयोगे धातुनामा हि नीचा नीचतरा अृता ॥ १३ ॥  
 संयोगान्ते विधा प्रोक्ता उत्तमा मध्यमाधमा ।  
 तात्त्वजासत्त्वयोर्योगे<sup>5</sup> नारीधातुः प्रजायते ॥ १४ ॥

(1) A and B read दुष्टा

(2) मुख्यप्राधान्यता is the correct reading. प्राधान्यता is grammatically incorrect.

(3) A and B have रक्तलोहतामृकैः, which mars the metre.

(4) A reads रजतेनैदृ, which is not correct.

(5) धातुः is used here in the feminine gender both by A and B.

(6) Vide verse 20.

एषा<sup>१</sup> मध्योत्तमा प्रोक्ता कार्यकारणयोगके ।  
 चपुताम्बसंयोगेन<sup>२</sup> जाता धातुष मध्यमा ॥ १५ ॥  
 सौसके<sup>३</sup> भङ्गदा प्रोक्ता कार्यकाले सदोहिता ।  
 अनेनैव प्रकारेण येन येन च कर्मसु ॥ १६ ॥  
 कर्तव्या जाघवो विद्या आत्मा<sup>४</sup> दुष्किंशिशारदेः ।  
 अभङ्गं सौसके जातं शुद्ध उत्पत्त्यकारकम् ॥ १७ ॥  
 हाटके श्वेतता जातेः<sup>५</sup> अच्छया<sup>६</sup> रजते यदि ।  
 लघुद्रावः शुभे शुखे लोहे च द्राविणौ कला ॥ १८ ॥

- (1) Both A and B read एत्, which is grammatically incorrect.
- (2) संयोगि is the reading in A and B, which mars the metre.
- (3) A and B reads शीशके.
- (4) A reads आत्मा, which is incorrect.
- (5) A and B read जाते, which is incorrect.
- (6) A reads अच्छयो. B reads अच्छमी. Both the readings seem to be incorrect.

जासत्वे अङ्गौना च काठन्याभ्यधिको परौ ।  
 कला एताश्च धातुनां जातेभवति शुद्धता<sup>१</sup> ॥ १८ ॥  
 कला एताद्यशी दिव्याः प्राप्तः<sup>२</sup> सिद्धसु जायते ।  
 शुद्धजासत्वसंयोगे नारीधातुसु<sup>३</sup> जायते ॥ २० ॥  
 कार्यनिककरौ प्रोक्ता पात्रामोदसु<sup>४</sup> कोमला ।  
 मारणे जारणे दिव्या चारणे बोटने तथा ॥ २१ ॥  
 निर्गन्धा वर्णरहिता जातिभेदकरौ स्फृता<sup>५</sup> ।  
 एतावद्<sup>६</sup> गुणसंयुक्ता कार्यकारणसंयुता ॥ २२ ॥

(1) जाते भवति शुद्धिताः, a variant in A. जाते भवति रशुद्धिताः, an incorrect variant in B.

(2) A and B read प्राप्ते, which is grammatically incorrect.

(3) A reads नारीधन्यत्वसु. B reads नारीधन्यवसु. Both seem to be incorrect. (Vide verse 14.)

(4) B reads पात्रामोदसु, which is unintelligible.

(5) A reads मता.

(6) Both A and B read एतद्, which destroys the metre.

संखारे; संखता सर्वे<sup>१</sup> सर्वसिद्धिकरो चृता ।  
 नानासुवर्णकार्येषु रूप्यकार्येषु संयुता ॥ २३ ॥  
 धातुधौता च या<sup>२</sup> धातुः सुधामायः सुसंखता ।  
 कार्यसिद्धिकरो<sup>३</sup> श्रेष्ठा ज्येष्ठकार्यविधायिका<sup>४</sup> ॥ २४  
 सर्वद्याशु सुधामायः<sup>५</sup> प्रासम्ब्रहणप्राहकः (?) ।  
 आहयेत् ग्रासमालेण पाचयेदशनं<sup>६</sup> स्त्रियम् ॥ २५ ॥  
 स्वकौयाशनसंपक्ते<sup>७</sup> जाते भवति सिद्धिदा ।  
 अन्यथा नैव सिद्धन्ति जायते चृग-अच्छुवत् ॥ २६ ॥

- (1) A and B want सर्वे, thus rendering the foot incomplete.
- (2) A and B read ये, which is not correct.
- (3) कार्यसिद्धिकरा is the variant in A and B.
- (4) A and B read विधायिका, which is grammatically incorrect.
- (5) A has an incomplete foot सर्वतेषाः. B also has सर्वे तेषुषा.
- (6) A reads पाचयेत् श्व. B reads पाचयेत् श्वं. Both of them seem to be incorrect.
- (7) B reads संयुक्ते.

## HINDU CHEMISTRY

तस्मात्तेव यदेन सुधामायः<sup>१</sup> सुसंखतिः ।  
यदीक्षसंखतियुता<sup>२</sup> सर्वतो धातुरस्तमा<sup>३</sup> ॥ २७ ॥

क्रियोचितसुसंखारान्<sup>४</sup> कारथेद्यदतः सदा ।  
यदीदितेसु संखारैर्युक्ता कार्यकरी सदा ॥ २८ ॥  
सर्वसञ्चासंयुक्ता धातुधौता सदैव हि ।  
जायते नैव सन्देहः कार्यकारणकारिका<sup>५</sup> ॥ २९ ॥

पार्वत्युवाच ।

कियत्परिमिता धातुः संख्या वदतु मे विभो ।  
उत्पत्तिर्लघ्यं तेषां स्थानं चैव<sup>६</sup> पृथक् पृथक् ॥ ३० ॥

(1) A reads सुधामाय. B reads शुधामाय. Both are unintelligible.

(2) Both A and B read संयुक्ता, which mars the metre.

(3) सर्वे ते धातुरस्तमाः, a variant in A and B, which is grammatically incorrect.

(4) A and B read only संखारा, which is incorrect.

(5) Both A and B read कारकाः, which seems to be incorrect.

(6) B reads स्थानं तेषां.

कथ्यतां देवदेवेश लक्षणसंस्कृतिः ।  
 भेदोऽभेदोऽय<sup>१</sup> योगश्च मारणं चारणं तथा ॥ ३१ ॥  
 पातनं द्रावणं चैव बोटनं जारणं तथा ।  
 सारणं जौवनं घरुणं गोपनं लेपनं पुनः<sup>२</sup> ॥ ३२ ॥  
 जातिभेदः सुगन्धश्च मिलनं जरणं परम् ।  
 समग्रं कथ्यतां देव उपधातुकारौ क्रिया ॥ ३३ ॥  
 महादेव उवाच ।  
 शृणु देवि प्रवच्छामि धातुख्यानानि लक्षणम् ।  
 उपधातुरनेका हि<sup>३</sup> तेषां मारणचारणम् ॥ ३४ ॥  
 अक्षयं राग(?)<sup>४</sup>कारं च शोधनं वन्धनं तथा ।  
 मारणादि च यत् प्रोक्तं तत् सब्दे शृयतां शुभे<sup>५</sup> ॥ ३५ ॥

- (1) भेदभेदाय is the incorrect reading in A and B.
- (2) A reads युतः, which is senseless.
- (3) उपधातुरजेकानि, an incorrect variant in A and B.
- (4) Both A and B want this word, which may be supposed to be राग or वल here.
- (5) तत् सब्दे कथ्यानि ते, a variant in A.

पार्वत्यवाच ।

प्रथमं वद देवेश धातुनुक्रमस्त्रणम् ।

प्रत्येकस्यानरूपं हि गुणसम्बन्धकारकम् ॥ १६ ॥

महादेव उवाच ।

शृणु दं वि प्रयत्नेन सिद्धान्तवचनं मम ।

येन विज्ञानमात्रेण जायते धातुकृत्तिया ॥ १७ ॥

प्रथमे धातुनामानि संचेपात् कार्यकारणम् ।

कथयामि च ते भट्टे पश्चात् स्यानस्त्र संपदः<sup>१</sup> ॥ १८ ॥

भाद्रौ सुवर्णनामानि संचेपात् शृणुतां प्रिये ।

स्वर्णं सुवर्णं सूर्यैव इटकं वल्लिरोचनम् ॥ १९ ॥

सु(स) रङ्गं च तथा सोहं देवधातुर्भनोहरम् ।

वेशी<sup>२</sup> विज्ञासगं चैव धर्मदं क्षषिदेवता ॥ २० ॥

जीवनम् अबृतं चैव हेम<sup>३</sup> हिमवतोऽवम्<sup>४</sup> ।

देववल्लभगं दिव्यं संसारोत्तारणं महत् ॥ २१ ॥

(1) Both A and B read संपदि, which has no sense.

(2) A reads वशी.

(3) हेम is generally used

(4) हिमवद्द्रवं is the correct term.

जौवनं सर्वलोकानां<sup>१</sup> नारीणां रस्तनं शुभम् ।  
 अन्यानि विविधनामानि<sup>२</sup> गोप्यगोप्यतराणि च<sup>३</sup> ॥ ४२ ॥  
 रजतं च तथा रुप्यं चन्द्रचन्द्रस्य दीपकम् ।  
 शुभ्रज्योतिःकरं<sup>४</sup> स्वर्णेषद्वौजं तारकं तथा ॥ ४३ ॥  
 अनन्ता वर्तते तेषां कथा द्विकराण ये ।  
 स्थापितं लौकिकं चैव<sup>५</sup> येनापन्वसनूहनम् ॥ ४४ ॥  
 शौतबौर्यं लघुबौर्यं विष्वनं वातनाशनम् ।  
 रसपुष्टीकरं शौदं धातुपुष्टनकारकम् ॥ ४५ ॥

(1) The first term in the previous verse is only जौवन'. But here it is सर्वलोकजौवन'. Hence there is no repetition.

(2) चन्द्रानि विविधात् नामात्, an incorrect variant in A and B.

(3) गोप्यगोप्यतराणि च is the reading in A and B, which has no clear sense.

(4) A and B read शुभजीतिकरं, which is incorrect.

(5) A reads लौकिका येना, which leaves out चैव.

रतिदं बहुवीर्यं च शुभधाम च संक्षयम् ।  
 एतानि रजतमामानि शताव्यग्यानि सन्ति वै<sup>१</sup> ॥४६॥  
 ताम्बं च<sup>२</sup> त्युञ्चकाधिष्ठं शुल्खं नागस्य मर्हनम् ।  
 जौलं च नीलविभूमं वमनं<sup>३</sup> चैव पातकम् ॥ ४७ ॥  
 उष्णम् उष्णकरं सिंहं क्षकशं कालमर्हनम् ।  
 हेमगर्भं<sup>४</sup> च कामोदं विषदं विषनाशनम् ॥ ४८ ॥  
 आरत्तस्त्र सहायस्त्र<sup>५</sup> मर्मयो मार एव च ।  
 एतानि शुल्खनामानि अव्यानि विविधानि च ॥४९॥  
 जास्त्रत्वं च जरातीतं राजतं यशदायकम् ।  
 रुप्यभ्राता वरीयस्त्र द्रोटकं कोमलं लघु ॥ ५० ॥

(1) A has शताव्यानि वर्तते. B has शतानानि वर्तते. Both the readings are grammatically incorrect.

(2) च is dropped in A and B.  
 (3) The sense of जौलविभूमं seems to be नीलविभूमं—  
 जौलबीभूम्. A reads चमनं, which is incorrect.

(4) A reads हेमगर्भे.

(5) A and B read सहाय च.

चर्मकं खर्परं चैव रसकं रसवर्हकम् ।  
 सदापथ्यं बलोपेतं पीतरागं सुभन्नकम् ॥ ५१ ॥  
 एतत्तु<sup>१</sup> खर्परनाम कार्यकर्मसु सिद्धिदम्<sup>२</sup> ।  
 रसराजार्दकं कर्म<sup>३</sup> क्षतं सिद्धिषु<sup>४</sup> जायते ॥ ५२ ॥  
 वपुस्थापहरं वह्नं रजतारिष्ठ<sup>५</sup> नौरदम् ।  
 श्रीतवौर्यकरं श्रीदं रतिदं तापहारकम् ॥ ५३ ॥

(1) रसचार्दक, the reading in A and B, is not grammatically correct.

(2) तते is the reading in A and B; which is incorrect.

(3) Both A and B read कार्यकर्मसु सिद्धिदान्, which is grammatically incorrect.

(4) रसराजार्दकान् कर्मान्, an incorrect variant in A and B.

(5) A reads छते सिद्धिषु. B reads छते सिद्धिषु. Both are incorrect.

(6) Both A and B read रजतानि च, which is senseless here.

मे हन्तं माहसाद(?)भूतं सहायं धातुशेषयोः ।  
 एतानि व्रपुनामानि सुसिद्धं कार्यकारकम् ॥ ५४ ॥  
 सौसक<sup>१</sup> धातुभङ्गं च गृतकं रोचकं परम् ।  
 रक्तं च रक्तवीर्यं च<sup>२</sup> रक्तवस्तुविवर्द्धनम् ॥ ५५ ॥  
 अन्तरुद्धयं च गच्छीरं धातुभज्जनकारकम् ।  
 ग्राहकं रसराजेन अक्षोभ्याक्षोभणं परम् ॥ ५६ ॥  
 विचित्रं विनतं चैव नानारक्षप्रदायकम् ।  
 नागं नगालं ग्रं प्रोक्षं सिद्धकं कण्ठशोधनम् ॥ ५७ ॥  
 षण्डुं षण्डकर<sup>३</sup> चैव दुरितं षण्डकारकम् ।  
 एतानि<sup>४</sup> नागनामानि कार्यकाले प्रयोजयेत् ॥ ५८ ॥  
 लोहं च आयसं शूरं सूर्यकर्मविशारदम् ।  
 हन्तकं खुननं स्तर्णमारकं<sup>५</sup> ताटकं मलम् ॥ ५९ ॥

- (1) सुसिद्धे कार्यकारकान्, an incorrect variant in A and B.
- (2) A and B read शौशकं.
- (3) B has only रक्तं दोयं च, which is incomplete.
- (4) A reads षण्डुं षण्डकरं चैव.
- (5) A and B read एतते, which is incorrect.
- (6) A has स्तर्णे प्रारकं. B has स्तर्णे मारकं

अजरं च जरायुक्तं धात्वाद्यम् अवनौसुतम् ।  
 कालेयं जीषणं कालं दधिरं रोगनाशनम् ॥ ६० ॥  
 यन्विदं सर्वधातूनाम् अक्षोभ्यं जलवड्हिषु ।  
 वड्हिदं वड्हिवीजं च सर्वधातुसहायकम् ॥ ६१ ॥  
 एतानि लोहनामानि ज्ञात्वा कर्माणि कारयेत् ।  
 जायते<sup>१</sup> सकला सिद्धिर्वियोगयोगसंयुताः ॥ ६२ ॥  
 नामानि धातसंयोगे जातानि तानि च शृणु<sup>३</sup> ।  
 शुखखर्परसंयोगे जायते पित्तलं शुभम् ॥ ६३ ॥  
 पित्तलं चैव नारोकं कफदं गन्धदुर्ज्यम् ।  
 वर्णदं दुर्बलं चैव राजतं वज्रभं लघु ॥ ६४ ॥  
 वज्रतास्त्रसंयोगेन जायते तेन<sup>४</sup> कांस्यकम् ।  
 कांस्यकं कोमलं चैव नेरसं रसकाठिनम्<sup>५</sup> ॥ ६५ ॥

(1) A reads नीयते.

(2) विद्योगायोग is the variant in A. विद्योगायोग is the variant in B. Both the readings seem to be incorrect.

(3) जातानि च ते शण, an incomplete variant in A and B.

(4) A has जातेनैव. B has जायते तेनैव.

(5) A and B read erroneously काठिदं.

तीव्रनादं महाशब्दम्<sup>1</sup> उपकान्ति रविग्रहम् ।  
 अवालापिधानं रौद्रं च याहकं<sup>2</sup> धूम्बरोधनम् ॥ ६६ ॥  
 एतानि<sup>3</sup> कांस्यनामानि कार्यकाले प्रयोजयेत् ।  
 वस्थने धारणे चैव सुदणे धूमवस्थने ॥ ६७ ॥  
 खर्परैः सह पारदं दिव्यं<sup>4</sup> किञ्चित् प्रसिद्धयेत् ।  
 जायते रसको नाम नानारोगहरो भवेत् ॥ ६८ ॥  
 नागस्तु रहते<sup>5</sup> होनो मृतधातुस्तु जायते ।  
 स एव कोमलाम्निख्यः<sup>6</sup> सिन्दूरं जायते ध्रुवम् ॥ ६९ ॥

- (1) A reads महाशब्दं. B reads महतशब्दं. Both the readings are incorrect.
- (2) A reads याहकं, which has no clear sense.
- (3) And B read एतानि, which is incorrect.
- (4) पारदो दिव्यो is the reading in A and B, which is incorrect.
- (5) B reads रहते, which is not correct.
- (6) कोमलाप्रिष्ठे is the reading in A and B, which is not correct.

अनेकाः<sup>१</sup> साधयैहिद्या मन्त्रयन्त्रकरोः क्रियाः ।  
 पूजनार्थे मम गुणाः सर्वे कल्पितरोचनाः<sup>२</sup> ॥७०॥  
 तामदाहजलैर्योगे जायते तुत्यकं शुभम् ।  
 नाना रसायनौ विद्या साधयेत् सा<sup>३</sup> सदेव हि ॥७१॥  
 रसरसक(?)<sup>४</sup>योगेषु राजमर्यादा जायते ।  
 राजकं जायते नाम नारी राजकलागतिः<sup>५</sup> ॥७२॥  
 संयोगे साधनं दिव्यं वियोगे साधनं शुभम् ।  
 वियोगं पुननैर्योगं रसताम्बे शुभो विधिः<sup>६</sup> ॥७३॥

- (1) A reads एनेका. B reads एतेका. Both are incorrect.
- (2) A and B read कल्पितरोचनं.
- (3) सा is not found in A and B.
- (4) A and B read रसारसयोगेषु, which is incomplete.
- (5) नाराराजकलागतिः, a variant in A. नाराजकलागतिः, a variant in B. Both the readings seem to be incorrect.
- (6) A and B read शुभविधिः.

अनेका साधनौ विद्या साधयेद्व्यकाङ्गितम्<sup>1</sup> ।  
लभते रसायनौ विद्या स्वखोऽपि विज्ञतोष्यमौ ॥७४॥  
अनेनेव प्रकारेण ज्ञायते नाम कर्म्मभिः ।  
नामकर्म्मज्ञता<sup>2</sup> जाते चित्ते निर्म्मलता<sup>3</sup> भवेत् ॥७५॥  
एतच्चे कथिता धातोरुपधातोरु तां<sup>4</sup> शृणु ।  
येन विज्ञानमादेण कालकाल्या<sup>5</sup> न सिष्यते ॥ ७६ ॥  
उपधातोरु मध्येषु श्रेष्ठा माता रसायनौ ।  
तस्या नामानि वशामि पशात् स्वानगुणानपि<sup>6</sup> ॥७७॥

(1) A reads द्रव्यकोङ्खिनः. B reads द्रव्यकाङ्खितः.

(2) A and B read नामकर्म्मददाते, which is unintelligible.

(3) A and B read निर्म्मला, which is not grammatically correct.

(4) A and B read ते, which is incorrect.

(5) A reads कालकाल्य. B reads कालकाल्य. Both the readings are incorrect.

(6) Both A and B read गुणानि च, which is incorrect.

हरितालं विसङ्गा च रङ्गदीसिकरौ सदा ।  
 तालं च हरिता हंसी खेतपौतविधायिनौ ॥ ७८ ॥  
 नर्तकस्य प्रिया देशी निशा चैव निशाचरौ ।  
 पारदस्य अयकरौ पञ्चच्छेदकरौ स्फुता<sup>१</sup> ॥ ७९ ॥  
 रोगहा जौविनौ जेवी जरादारिद्रनाश्यिनौ ।  
 एतानि तालनामानि संक्षेपात् कथितानि ते<sup>२</sup> ॥ ८० ॥  
 युक्तो ज्ञानेन यः<sup>३</sup> कर्त्ता अच्छोभ्यो<sup>४</sup> जायते सदा ।  
 अनेनैव प्रकारेण कर्त्ता कर्माणि साधयेत् ॥ ८१ ॥  
 मनश्चिला शिला शृङ्गी कुनटी च क्षतोद्यमा ।  
 दरदा<sup>५</sup> भगिनी देशी सिन्दूरस्य सखो सदा ॥ ८२ ॥

- (1) The 78th and 79th slokas are not found in A.
- (2) संक्षेपे चिकथानिजे, a variant in A and B, which has no sense.
- (3) युक्तज्ञानेन यै, an incorrect variant in A and B.
- (4) A reads अच्छोभ्यो, which is incorrect.
- (5) B reads दरदा.

पुष्पा पुष्पवती<sup>१</sup> पद्मी शालिनी रसिनी गुणा ।  
 एतत्तु च शिलानाम<sup>२</sup> कार्यकासे प्रयोजयेत् ॥८३॥  
 अभ्रकं चैव व्योम<sup>३</sup> च गगनं आहकं परम् ।  
 दुष्टवीर्यस्त्रिवातस्त्र वङ्गिनादोत्ताष्ट्राति ॥ ८४ ॥  
 अजरम् अमरं घोरं घोरषश्छत्रुनाशनम् ।  
 रंसमूलरसातीतं रसज्ञे राज्यवर्षनम् ॥ ८५ ॥  
 अमृतम् अमरं<sup>४</sup> चैव महामृत्युविनाशनम् ।  
 एताग्न्यभ्रकनामानि ज्ञात्वा कर्म्माणि कारयेत् ॥८६॥  
 सोमलं मङ्गराजं च विषं वातविनाशनम् ।  
 खेतवीर्यं बलग्रन्ति नौलउच्चालकारकम् ॥ ८७ ॥  
 खेदनं भेदनं चैव कामवीर्यविवर्षनम् ।  
 बन्धनं सर्वधातुनां मारणं पारदे रसे ॥ ८८ ॥

- (1) A reads पुष्पवर्ती.
- (2) एतत्ते च शिला नामान्, an incorrect variant in A and B.
- (3) Generally used as व्योम.
- (4) A reads वङ्गिनादे एतः चतिः, which is incorrect.
- (5) A and B read ऊच्छत्र, which is incorrect.
- (6) A repetition of the name.

गगनयाहके दिव्ये रसयुग्मे प्रमेलनम् ।  
एतानि मङ्गनामानि कायंकाले प्रयोजयेत् ॥८७॥  
हीनधातोश्च नामानि संचेपात् तानि च शृणु<sup>१</sup> ।  
येन विज्ञानमावेष जायते पारदो क्रिया ॥८८॥  
सुक्षा सुक्षाफलं वारि वारिजं स्खातिसम्भवम् ।  
शुक्रिगम्भे<sup>२</sup> च सगरं शृङ्गारं मङ्गलोदयम् ॥८९॥  
तैजसम्<sup>३</sup> अमृतोद्भूतं श्रीतलं शिलोर्म भनः<sup>४</sup> ।  
स्खयम्भुवं कलं दीप्तं<sup>५</sup> स्त्रियि सौभाग्यदायकम् ॥९०॥  
रतिराजग्रहः शोभाकामसम्बोधनं तथा ।  
सुक्षानामानि रस्याणि<sup>६</sup> ज्ञात्वा कर्माणि कारयेत् ॥९१॥

- (1) A reads वते शृणु, which is incorrect.
- (2) B reads मुक्तिगम्भे, which is not correct.
- (3) B reads तैजसं, which is incorrect,
- (4) B reads ननः, which is not correct.
- (5) शौष्ठि सौभाग्यदायिनि, an incorrect variant in A and B.
- (6) A and B read ते रसान्, which is incorrect.

विद्वमं वरद<sup>१</sup> विलावङ्गोजातं प्रवालकम् ।  
 नौरसम्<sup>२</sup> अधरेसीमा शिखरं शिखरोङ्गवम् ॥ ८४ ॥  
 वर्णदं विवरं चैव यैवेयं च विभूषणम् ।  
 विद्वमस्येतत्तामानि<sup>३</sup> कार्यकाले प्रयोजयेत् ॥ ८५ ॥  
 चर्मकं कूर्मकं चैव कमठपृष्ठं सकालकम् ।  
 कमठं कर्कशं चैव कलिङ्गातं माशभम् ॥ ८६ ॥  
 कचकं कहुः<sup>४</sup> कर्म लोके कचकटं तथा ।  
 एतानि कूर्मपृष्ठस्य नामानि च विशेषतः ॥ ८७ ॥  
 यहुं च अलजं चैव देववादिवमेव च ।  
 विच्छुवङ्गभक्तं चैव सोमदैवतकं शभम् ॥ ८८ ॥

- (1) A reads विद्वमि वरदं. B reads विद्वमि वरदै.
- (2) A reads नौरसै.
- (3) A and B read यैवेयं.
- (4) A has विद्वमेनानि. B has विद्वमेनानि. Both are incorrect.
- (5) कलिंवनाशर्म is an incomplete variant in A and B.
- (6) A has कम्बककहुः. B has कचकहुः.
- (7) B reads erroneously विच्छुवङ्गभाभक्तं.

वरायुधं च वरदं शुभं माङ्गल्यदायकम् ।  
 अजेयं सर्वजन्मूर्त्ति दानवाख्यं वरोदयम्<sup>1</sup> ॥ ११ ॥  
 गच्छीरं घोषशब्दं च पवित्रं पारदं गृहम् ।  
 एतानि<sup>2</sup> शंखनामानि वामदक्षिणकाव्यमौ<sup>3</sup> ॥ १०० ॥  
 शुक्लिका सौफिका<sup>4</sup> कान्ती मुक्तामाता गरीयसी ।  
 चन्द्रपद्मी पथोग्राही संपुटी पटवादिनी ॥ १०१ ॥  
 रजताभासिनी दीप्ता वङ्गवारिविशेषणी ।  
 पञ्चकरीगतिः पञ्चगर्भं समुद्रसन्धवा ॥ १०२ ॥  
 उत्तमा मध्यमा नौचा त्रिविधा सागरोद्धवा ।  
 नद्युद्धवा तु सा नौचा<sup>5</sup> नौचकर्मविश्वारदा ॥ १०३ ॥

- (1) Both A and B read वरं देयं, which destroys both grammar and metre.
- (2) A and B read एतसे, which is grammatically incorrect.
- (3) A reads वामदक्षिणवाक्यमौ. B reads वामदक्षिणमातुमौ.
- (4) B has only सौका.
- (5) A and B read पञ्चगर्भं
- (6) नद्युद्धवा तद्वीचा, an incomplete variant in A. नद्यीद्धवा दद्वीचा, an incorrect and incomplete variant in B.

एततु सच्चणं शुलोः<sup>१</sup> कर्मकाले प्रयोजयेत्<sup>२</sup> ।  
 आत्वा यः कुरुते कर्म सिद्धयेत् सकलं फलम् ॥१०४॥  
 गजोद्भवं रदं<sup>३</sup> दन्तं छिं चैव तु पुष्पकम् ।  
 नारीसीभाग्यदं चैव गजभूषणसम्मुखम् ॥१०५॥  
 तेलरक्षाकरं श्रीदं संपुटं पुष्टिकं तथा ।  
 नामानि गजदम्तस्य अन्यानि मध्यमानि च<sup>४</sup> ॥१०६॥  
 पिञ्छकं कुर्कुठं च व शिखिपिञ्छं सुचित्रकम् ।  
 हरिमौलिधरं श्रीदं मोहनं चन्द्रकं तथा ॥१०७॥  
 नागारिं सर्पदमनं विषदं विषनाशनम् ।  
 एतानि शिखिपिञ्छस्य नामानि विविधानि च  
 ॥१०८॥

- (1) A and B read एतते सच्चाण शुलि, which is an incorrect variant.
- (2) कर्मकार्ये प्रयोजने, a variant in A, which seems to be incorrect.
- (3) A reads वरद, which is incorrect.
- (4) चर्वले मध्यमानि च, a variant in A and B, which is grammatically incorrect.

न खं सङ्कृदयपुरं धातुकोमलकारवस्त्रं ।  
 वज्रं दुर्गं निकं चैव तुरीटापसु चोभकम् ॥१०८॥  
 कचं केशं च बालं च मूर्द्धजासकमेव च ।  
 श्वामं चैव घनं प्रोक्तं कर्कशं भर्मदं सघु ॥ ११० ॥  
 एतानि धातुगामानि यथाकर्माभिधानवत्तम् ।  
 ज्ञात्वा आरभ्यते कर्म स्वस्ये सिद्धिः प्रजायते ॥१११॥  
 पार्वत्युवाच ।

शशो शहूर विश्वेश विश्वनाथ अगदगुरो ।  
 त्रुतानि चैव नामानि स्थानानि कथन्तां प्रभो ॥११२॥

- (1) न इदयपुरं, a variant' in A- न इदयपुरं, a variant in B. Both are incorrect.
- (2) B reads आरक्षं.
- (3) B reads वज्रे, which is not correct.
- (4) A reads तुरीटापसु चोभकम्.
- (5) A and B read कथन्तां, which is grammatically incorrect.

### महादेव उवाच ।

शृणु देवि प्रथलेन स्थानानि विविधानि च ।  
 सुबर्णस्योदयो धातोः सर्वव्यापकपर्वते<sup>१</sup> ॥ ११३ ॥  
 पार्थिव्यं हि च तत् सर्वे<sup>२</sup> मृदामध्यात् प्रजायते ।  
 तस्मात् स्थानस्य संक्षेपः अयतां सादरं<sup>३</sup> शुभे ॥ ११४ ॥  
 हेमं च प्रथमं कल्पं मेहमध्ये सदैव हि ।  
 दुर्जनं मर्ख्यलोकेषु कष्टेनैव तु स्थिते ॥ ११५ ॥  
 पुनर्हेमाद्रिणा तेन जायते सर्वदा शुभे ।  
 महाशौतकाते<sup>४</sup> तेन दुर्जनं स्थात् सदैव हि<sup>५</sup> ॥ ११६ ॥  
 पश्चात्प्रस्तूनदीद्वृतं अस्त्रूदौपेषु जायते ।  
 तत्र कष्टतरं मन्ये दुर्जनं तत् सदैव हि ॥ ११७ ॥

- (1) A reads वचोत्. B reads पर्तात्. Both the readings are incorrect.
- (2) पार्थिव्यानि च ते सर्वे, an incorrect variant in A and B.
- (3) A and B read सादरात् which is incorrect.
- (4) A reads नहत् सौतङ्गवै, which is incorrect.
- (5) B reads सदैव हि, which is incorrect.

पृथिव्यां धातुमध्येषु सर्वेषामधिकं सदा ।  
 लोहाधिकतरं तत्र ज्ञातव्यं सर्वदा शुभे ॥ ११८ ॥  
 कष्टे निःसारणं तेषां मौख्यादधिकं जायते ।  
 तस्मात्सनैव यद्बेन साधनं क्रियते नरैः<sup>१</sup> ॥ ११९ ॥  
 असाध्यसाधनं तस्य जातं सर्वयुगे शुभे ।  
 तस्मात्तु<sup>२</sup> बहुमूल्येन सर्वधातूपरिस्थितिः<sup>३</sup> ॥ १२० ॥  
 पुनः स्थानं क्षतं तेन लक्ष्यार्थं च सदैव हि ।  
 उद्भृतं तेन यद्बेन मर्त्तादृभौतं मया शुभे ॥ १२१ ॥  
 पार्वत्युवाच ।  
 महारुद्र शङ्कर श्रीमन्<sup>५</sup> लोकनाथ जगत्‌पते ।  
 कथं ते मानुषे भौतिः<sup>६</sup> कथतां परमेश्वर ॥ १२२ ॥

(1) A has ज्ञयते नराः. B has ज्ञयते नराः. Both are incorrect.

(2) A and B read तस्माते, which is incorrect.

(3) सर्वधातीपरिस्थितिः, an incorrect variant in A and B.

(4) A and B read erroneously चत्वारं.

(5) श्रीमान्, a reading in A and B, is not correct.

(6) मानुषाद्भौतिः is the correct form.

महादेव उवाच ।

सुवर्णस्यैषा महतौ<sup>१</sup> भौतिर्मानुषसचावा ।

उद्दो नौचपदं सम्यक् जायते बहुसे रतिः ॥ १२३ ॥

मथा मानुषभौतेन<sup>२</sup> उङ्कितं सादरीश च ।

दुर्जं च विशेषेण प्राक् कलियुगी इदम्<sup>३</sup> ॥ १२४ ॥

पाव्यन्त्युवाच ।

मदाय मानस नाथ जाताऽसा समया महान् ।

भवतां मानुषौ भौतिः कथं तु जगदीश्वर<sup>४</sup> ॥ १२५ ॥

महादेव उवाच ।

कारणं वर्तते देवि अव्यास्येयं सदेव हि ।

कथनौयं त्वयि भद्रे यतस्य<sup>५</sup> मम वक्त्रभा ॥ १२६ ॥

(1) A and B read सुवर्णस्यैषा महान्, which is not correct.

(2) नां च मानुषीभौतेन, an incorrect variant in A and B.

(3) A and B read इमे. This foot is incomplete.

(4) A reads वक्त्रं ते जगदीश्वरं. B reads वक्त्रं ते जगदीश्वरः. Both are incorrect.

(5) वक्तेन is an incorrect variant in A and B.

दुष्टिचतुरताद्विजिते च कलौ युगे ।  
 मानुषे च भवतौह<sup>१</sup> मम शोभानुवर्त्तनी ॥ १२७ ॥  
 तस्मात्तैर्बहुले<sup>२</sup> द्रव्ये साधते गन्धकी क्रिया ।  
 अथवा पारदी चैव मम शोभानुवर्त्तनी ॥ १२८ ॥

पार्वत्यवाच ।

श्रुता सा गन्धकी विद्या सर्वसौभाग्यदायिनी ।  
 सङ्कभज्ञता सा च<sup>३</sup> न सिद्धति गरीयसौ ॥ १२९ ॥  
 भवता पूर्वमुक्तं हि सङ्कभज्ञणयोगतः ।  
 न सिद्धति च ते विद्या सदा गन्धकपारदी ॥ १३० ॥  
 तस्मात् कथतां देव मनोऽस्मानिविवर्जितम् ।  
 सुवर्णसाधिनीं विद्यां<sup>४</sup> तस्माद्वद्वद्गु मे विभो ॥ १३१ ॥

- (1) A and B read भवतौह, which is not correct.
- (2) A and B read तस्माते, which is incorrect.
- (3) A and B read ते च.
- (4) A reads मन.
- (5) A and B read सुवर्णसाधिनी विद्या.

**महादेव उवाच ।**

मानसं मद्दीयं देवि जातं सम्यक् सुनिर्मलम् ।

तथापि मानुषे भौतिकिद्या<sup>1</sup> गन्धकपारदौ ॥१३२॥

सङ्घभक्षणं कष्टम्<sup>2</sup> उभे मेलापनं महत् ।

सुषु मम्ब्रजाते वङ्गो ज्वलते तत्कृष्णात् ततः ॥१३३॥

मन्दवत् साधयेद्विद्यां साधयेद्यद्वतः क्रमात् ।

तस्मात्तेनैव महता गोप्या सिद्धिकारी क्रिया ॥१३४॥

**पार्वत्युवाच ।**

पुरा प्रोक्तं त्वया नाथ पट्टे पञ्चदशके<sup>3</sup> ।

कैलासात् परमं सौख्यं भजते मन्दविज्ञानः ॥१३५॥

क्रिया गन्धकिनौ<sup>4</sup> मध्ये अथवा पारदौ शुभे ।

कैलासाद्विकं सौख्यं सुख्ते विधिवद्वराः<sup>5</sup> ॥१३६॥

- (1) A and B read विषे, which is senseless.
- (2) A and B have आङ्, which is incorrect.
- (3) पट्टे पञ्चाचिके, a variant in A and B, which is incomplete.
- (4) A and B read गंधकिना.
- (5) A and B read वरः, which is incorrect.

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महादेव उवाच ।

निर्मलं मानसं जातं तव वाक्यविमोहितम् ।

कथयामास ते भद्रे गुणलक्षणसंयुतम् ॥ १३७ ॥

खर्णीतपत्तिखलः^१ नित्यं सर्वचापि विधीयते ।

उत्पादनगतिस्तस्य खाने खाने पृथक् पृथक् ॥ १३८ ॥

अङ्गतां वरदे देवि खाने चैव यथोदितम् ।

तस्य वातोत्यजा रेणुर्धमने खर्णे^२ जायते ॥ १३९ ॥

पावकाद्रेभुवावाहुः^३ सप्तरबाकरे तथा ।

समुद्रस्य तटे दिव्ये खानं खात् खर्णकस्य च ॥ १४० ॥

खल्यं च सिन्धुदेशेन कामरूपैस्तथैव च ।

अन्येऽनु विविधैः खानैः साम्रातोत्पत्तिर्जायते ॥ १४१ ॥

- (1) A and B read हंयुतः, which is not accurate.
 (2) Both A and B read खर्णीतपत्तिः खर्ण, which is not correct.
 (3) A and B add च after खर्णे.
 (4) A reads पावकाद्रस शमावाहु. B reads पावकाद्रस अवावाहु.

तत्त्वं तत्त्वोत्पत्तिस्तेषां यद्व यद्व हिमद्रवः ।
 प्रसरन्ति भुवि संधाः^१ संशयो नास्ति ते सदा ॥१४२॥
 तात्त्वोत्पत्तिस्त भृता सुखेनैव प्रजायते ।
 तेषां स्थानानि वस्त्रेऽहं^२ याथात्येन च शूलः^३ ॥१४३॥
 निपाले कामरूपे च^४ वङ्गाले मदनीश्वरै^५ ।
 गङ्गाधारे मलाद्रौ च व्याघ्रदेशे तथैव च ॥ १४४ ॥
 पावकाद्रौ जीर्णदुर्गे रूमदेशे फिरङ्गके ।
 एतान्युदितस्थानानि^६ सर्वपर्वतके^७ सदा ॥ १४५ ॥
 आसत्वं यस्तु^८ दिव्यं हि स्थानानि तस्य च शूलु ।
 कुम्भाद्रावय^९ कामोजे रूमदेशे बलचति ॥ १४६ ॥

- (1) अंगे is the variant in A. अंगे is the variant in B.
- (2) स्थानान् प्रवस्त्रेऽहं is the incorrect variant in A and B.
- (3) A and B read ते शब्द.
- (4) निपालं कामरूपं च, a reading in A and B.
- (5) वङ्गालं मदनीश्वरं, a variant in A and B.
- (6) एतानि उदितस्थानान्, an incorrect variant in A.
- (7) A and B read चुपर्वतमि, which is incorrect.
- (8) A and B read वस्त्रे.
- (9) A and B read श्वारेष, which is incorrect.

एतान्युभयोः स्थानानि^१ रजःस्थानं च^२ उच्यते ।
 जासत्वं वक्ष्यात् नागं नेपाले च सदैव हि ॥ १४७ ॥
 केदारे कर्मकाण्डे च व्रग्म्बके विपुरे तथा ।
 एतत्स्थानानि दिव्यानि^३ गोप्यान्यन्यानि
 तानि ह^४ ॥ १४८ ॥
 लोहाद्रौ^५ लोहात् कर्मा गयाद्रौ^६ गौतमाद्रिके^७ ।
 विघ्नमध्ये^८ हि सर्वच नलाद्रौ^९ निष्कलेऽपि वा
 ॥ १४९ ॥

- (1) एति उभयोः स्थानात्. a reading in A. एति उभयोः
स्थानात्, a reading in B.

(2) A and B read रजस्थानी.

(3) A and B read स्थानस्थान् दिस्थान्.

(4) चमा बोचा तितेति ह, a variant in A and B, which
is senseless.

(5) A and B read जीष्टादे, which is incorrect.

(6) Do. Do. वरादे, Do.

(7) Do. Do. जीतनाद्विष्टे, Do.

(8) Do. Do. वंशनष्टे, Do.

(9) Do. Do. वरदे, Do.

वग्नके विमले^१ चैव लोहाकशालिवाहने ।
 समुद्रस्थ तटे रम्ये आद्ये अन्ते च मध्यगी ॥ १५० ॥
 लोहस्यैतानि स्थानानि^२ हाटकैश्च^३ सदैव हि ।
 किञ्चित्^४ गोप्यानि दिव्यानि संखारैः रहितानि च^५
 ॥ १५१ ॥

युक्ते तु संखाते तेषु स्तर्णीं सिद्धिः प्रजायते ।
 अयुक्ते नैव लभ्या तु^६ युक्ते प्राप्तिः सदैव हि ॥ १५२ ॥
 पारदे गन्धके धात्वोः योग शौषधकात्^७ सदा ।
 मानसे निर्मले चैव लभ्यते^८ हाटकी क्रिया ॥ १५३ ॥

- (1) A reads विमले.
- (2) लोहस्यैतानि च स्थानात्, a variant in A and B, which is incorrect.
- (3) A reads हाटकै च.
- (4) किञ्चित् is the reading in A and B, which is incorrect.
- (5) A reads से. B reads ते.
- (6) A and B read स्तर्णते, which is not correct.
- (7) Do. Do. शौषधकात्, D_१.
- (8) Do. Do. लभते, Do.

प्रव्यथा नैव सभ्या तु¹ विना मन्त्रेण सिष्यति ।
 तस्मादेव² प्रयत्नेन निर्मलं मानसं शुभम् ॥ १५४ ॥
 अशुभं समलं चैव मानसं सर्वदा भवेत् ।
 तस्मात् चतुराहारे³ सर्वदा शुभमानसः ॥ १५५ ॥
 जायते च क्रिया सिद्धा हाटकौ भवति सर्वदा ।
 मन्त्रसिद्धिः प्रजायेत् सर्वकर्माणि साधयेत् ॥ १५६ ॥
 अनेनैव प्रकारेण उत्तमा हाटकौ क्रिया ।
 सर्वकार्यकरौ नृणां चतुर्वर्गफलप्रदा ॥ १५७ ॥

महादेव उवाच ।

प्रोक्षसंपुटके चैव स्थूलकाचीयकेन च ।
 उषाङ्गारक्षाते चम्भी⁴ सुर्मुरं छागरेकजम् ॥ ८

- (1) A and B read सभ्यते, which is not correct.
- (2) A and B read तस्मादेव, which is not correct.
- (3) A reads चतुराहारे, which is unintelligible.
- (4) A reads छातेरपि. B reads चतेरपि.

खर्परात्ये पुटे चैव आरस्तोत्पलकेन च ।
 साईं विनास्ति(?)गति च ज्वलिते अर्दमर्दगे¹ ॥१०॥
 एवानुक्रमतो योगे पुटमिकं च जायते ।
 चतुरंश्चेन जासुत्वं सुवर्णाहापयेत् सुधीः ॥ ११ ॥
 प्रति संपुटपुटे चैव उद्धयेत् कुरुखर्पंरे ।
 स्वाङ्गश्चौतः² समुच्छ्व लेपसुत्तारयेत्ततः³ ॥ १२ ॥
 पुनर्लेपः प्रदातव्यः⁴ पुनः आरान् प्रदापयेत् ।
 पुनरेव घोटनं देयं सादरं पुनरेव हि ॥ १३ ॥
 अनेनैव प्रकारेण तुर्बांशसंपुटेन हि ।
 सुवर्णसंयुतं तत्त्वं⁵ गालयेत् आरसंयुतम् ॥ १४ ॥
 ज्वलिते तोक्षयत्वेव तिक्षाईं संपुटं प्रति ।
 नम्बीभूतं च रजेयं संक्षारैः शुद्ध साम्रातम् ॥ १५ ॥

(1) A and B read ज्वलितेरहंरह्वा.

(2) ज्ञानशीलेन is the reading in A and B, which is not accurate.

(3) A and B read वैष्णुत्तारवं वायः, which is incorrect.

(4) A and B read पुनर्लेपं वदात्वयः, which is not correct.

(5) A and B read हि च, which is incorrect.

एतत्क्रमक्रमेष्व सुवर्ण^१मनुसंचय ।
 तद्गुणे शोषिमापौते महत्तः प्रजायते ॥ १६ ॥
 आरत्तं पौतसंयुतं जायते हाटकं महत् ।
 हाटकं मत्तकं^२ चैव न च हौनेन योजयेत् ॥ १७ ॥
 कलागुणगते छुटिर्जायते उत्तमे नरे^३ ।
 अनेनैव प्रकारेण मात्राहिगुणं दापयेत् ॥ १८ ॥
 कलाकृत्यमिति छुटिर्दीपिता छुटिरिष्वते ।
 निहींषं जायते दिव्यं द्रश्यसंपत्तिदायकम् ॥ १९ ॥

पार्वत्युदाच ।
 अधिकेन स्तते तत्र^४ शोषपाने सुशोभने ।
 जायते कोट्ठशं देव संयोगे अधिके सति ॥ २० ॥

- (1) A and B read सुवर्णम्, which is not correct.
- (2) A and B read हाटके नरके चैव.
- (3) उत्तमो नरः, a variant in A and B.
- (4) A and B have कलाकृत्य.
- (5) A and B have ते च, which is incorrect.

महादेव उवाच ।

शोणपाने च संयोगे भङ्गदः अस्ति^१ निश्चयः ।
 हिगुणंशोणपानेन कलंकं जायते इषुभम्^२ ॥ २१ ॥
 वेष्टसंगं सुधनार्थं त्रिंशांशे दिक्पलोपमम् ।
 अतिरिक्ताक्षतं तज्ज जायते सगुणं महत् ॥ २२ ॥
 गालयेद्यन्नपूर्वेण क्षायेद्रससमांशके ।
 समांशे गन्धकं देयं शुर्वं पौतकं रागकाम् ॥ २३ ॥
 चयतुर्यांशकं तालं दापयेद्रसमोदितम् ।
 तदर्हं सादरं देयं महायेत् कन्धकारसे ॥ २४ ॥
 यामवितयमामर्हं^३ क्षायाशुच्कमण्डजे रसे ।
 अतिशुखेतरे खले अथवा लोहसंभवे ॥ २५ ॥

(1) A and B read भंगदा अस्ति, which is incorrect.

(2) Do. हिगुणे.

(3) Do. इष्म, which appears to be incorrect.

(4) Do. पौतक, which is senseless

(5) यामवितयमामर्ह, an incomplete variant in A and

B.

महीयेद्यद्वपूर्वेण छायाशोषितं कारयेत् ।
 काचकूप्ये प्रदातश्च^१ वङ्गिर्बालुशयन्दगः^२ ॥ २६ ॥
 नखसंख्यामिते यामे पाचयेद्वसं शोभने ।
 स्वाक्षर्यौते तु संजाते पुनः खन्ने निधापयेत् ॥ २७ ॥
 रसेनानेन आमही छायाशोषितं कारयेत् ।
 उक्तायामे रसे^३ दत्ते पुनः शोषं^४ प्रदापयेत् ॥ २८ ॥
 उक्ताम्बौ दापयत्येव पुनः संस्कारमाचरेत् ।
 संस्कारे विविधे जाते अभिपूर्वं क्रमोदिते ॥ २९ ॥
 जायते रसराजोऽसौ सब्वं सामर्थ्यदायकः ।
 संचयेत्तरुलार्द्धस्तु अतिविक्रमवेगवान् ॥ ३० ॥
 जायते प्रबला त्रुद्धिः विदिने सेवते यदि^५ ।
 सार्वदृष्टिक्रमेनैव दिने मासफलं सदा ॥ ३१ ॥

(1) प्रदातश्चा, a reading in A and B.

(2) श्लूगा, a reading in A and B.

(3) रसी is the variant in A and B.

(4) शोष्मे is the incorrect reading in A and B.

(5) A and B read सेवनेत्यपि, which is grammatically incorrect.

जायते नाव सम्बेदः सिद्धिर्गन्धकसच्चवा ।
अनेनेव प्रकारेण रससिद्धिः प्रकायते ॥ ३२ ॥

* * * * *

पार्वत्युवाच ।

ग्रेतता कर्मणा केन^१ जायते रजतेषु च ।
क्रमेण राजती सिद्धिः पश्चाद्वाटकसच्चवा ॥ ३८ ॥

महादेव उवाच ।

अथानन्तरता विद्या धातुसंख्यारकारिणी ।
जासत्त्वेऽ कठिने जाते शुद्धे कोमलकारिणी ॥ ३९ ॥
तथाच पौत्रशुद्धेषु जायते शुद्धनन्तरां ।
शूलु यद्दो क्रिया दिव्याः शुद्धजासत्त्वसच्चवाः ॥ ४० ॥
पिष्ठं हयसुरोत्थं च हिगुणं धातुतः सदा ।
अर्हन्तु दापयेत् स्नावे अर्हं निष्ठे च^३ रक्षयेत् ॥ ४१ ॥

(1) केन कर्त्तव्य, an incorrect variant in A and B.

(2) जावत् is the reading in A and B, which is not correct.

(3) A and B read निष्ठेन.

निर्मलं धातुजं द्रावं स्नावचूर्णेन ठालयेत् ।
 यदर्थं च स्त्रितं निर्जनं तत्कालं दापयेत् सुधोः ॥ ४२ ॥
 उपरि संपुटं देयं समुद्रकुक्कुटे पुटे^१ ।
 स्खाङ्गशीतं समुद्रत्वं जायते निर्मलं महत् ॥ ४३ ॥
 जासत्वे सोमलं देयम् उक्तभागेन^२ साम्रातम् ।
 चूर्णान्तरगतं क्षत्वा उक्तं जायते महत् ॥ ४४ ॥
 तदेव^३ जासत्वं चैव दिव्यम् उक्तुलगं सदा ।
 रुप्यादृं मेलयत्येव जायते शुद्धता शुभा ॥ ४५ ॥
 अनेनैव प्रकारेण धनं किञ्चित्प्ल जायते ।
 धने चैव तु संजाते कारयेदूर्ध्वजाः क्रियाः ॥ ४६ ॥

अतीव शोभना विद्या रसगन्धकजा सदा ।
अतिसौभाग्यदा सा' च साधके मुखदायिका ॥६८॥

- (1) समृद्ध कुकुटे पटे, a variant in A and B, which seems to be incorrect.

(2) उत्तमीय, a variant in A and B.

(3) A and B read स पथ, which is not correct.

(4) Do. ते Do.

एताहृशं च जासत्वं शोधितं गन्धकेन च ।
 धालधौतेन ताम्रे ण पुच्छितं¹ सुभगं सदा ॥ ६८ ॥
 पुच्छितं जायते दिव्यं शुखपौतं शुभोदितम् ।
 निर्मलं जायते तच्च हीनहाटकसन्निभम् ॥ ६९ ॥
 लघुता जायते तस्य किञ्चिकार्या गुरुता सदा ।
 जायते गुरुता दिव्या पुच्छिते हाटकेन च ॥ ७० ॥

२८ श-पटलादुड़ताः शोकाः ।
 पार्वत्यवाच ।
 पूर्वं सुक्षं त्वया नाथ धने सिद्धिस्तु जायते ।
 लघुद्रवज्ञते धातौ² वद³ किं तत्र सुष्ठुते ॥ ४३ ॥
 महादेव उवाच ।
 क्रिया अम्बे: शुभा तेषां द्रव्यसिद्धिविधायिनौ ।
 शृणु यद्देन तां भद्रे क्रियां रंगोति नागजाम् ॥४४॥

(1) A and B read पुच्छिते.

(2) A and B read धाते, which is incorrect.

(3) A reads वद. B reads वदः.

आनयेत् पारदं दिव्यम् अधजार्हविपातितम् ।
 क्षालयेद्यद्रपूर्व्येण खस्ते पिष्टं तु कारयेत् ॥ ४५ ॥
 तैलेनानेन आमर्हं भावना क्षणमावतः ।
 निम्बे डमरुके यन्मे अन्निं दद्याद्विचक्षणः ॥ ४६ ॥
 उत्थयेद्यामयुग्मे न स्वाङ्गशीतं समुद्धरेत् ।
 पुनः समाननागेन पूर्व्यवत् क्षालयेत् सुधौः ॥ ४७ ॥
 पुनरेव हठादम्बौ उत्तायामेन सिद्धति ।
 रसे हिवारके चैव हीनहेमोक्तमोक्तमः^१ ॥ ४८ ॥
 तौलिके रक्तिकायुग्मं दापिते वर्णपञ्चकम्^२ ।
 अनेनैव प्रकारेण जायन्ते षोडशं कलाः ॥ ४९ ॥
 द्रव्यहृष्टिकरं तत्त्वं जायते नात्र संशयः ।
 पुनरेव क्रिया रस्या पारदे नागचारिणी ॥ ५० ॥
 हिगुणे चारिते तत्र^३ जायते चन्द्रिका शुभा ।
 आभासेन शिखिधीवा जायते नात्र संशयः ॥ ५१ ॥

(1) हीनहेमोक्तमः, an incomplete variant in A.

(2) पञ्चकः is the reading in A and B, which is incorrect.

(3) ते च is the incorrect reading in A and B.

पुस्ति ते हीनहीमेन जायते क्रायविक्रायः ।
 अनेनैव प्रकारेण जायते धनसंपदः ॥ ५२ ॥
 अतजर्हं क्रिया या च^१ विद्या नागस्य सञ्चवा ।
 रसे तु नागजे चैव विधिनामेन वर्तते ॥ ५३ ॥
 तायते^२ सकला विद्या नागते सञ्च संभवा ।
 सर्वा सा^३ शोभना विद्या तौब्रदारिद्रग्नाश्चिनी ॥ ५४ ॥
 अथातः संप्रवर्ष्णामि वपूणां विधिसुत्तमम्^४ ।
 येन विज्ञानमावेण जायते रजतं महत् ॥ ५५ ॥
 अनेका राजतौ सिद्धिः जायते परमोत्तमा ।
 जायते धनसिद्धिः^५ जायते नाव संशयः ॥ ५६ ॥

- (1) A and B read शे च, which is incorrect.
- (2) A and B have ताते, which is incomplete.
- (3) A and B have ता, which is not correct.
- (4) A and B have विधिसुत्तमा, which is grammatically incorrect.
- (5) A and B have रात् instead of च, which is a tautology.

पार्वत्यवाच ।

वद वैभवदातारं^१ वङ्गं विज्ञानदायकम्^२ ।

श्रावा सिद्धिमवाप्नोति गुणज्ञैः सौख्यकं च यम् ॥५७॥

महादेव उवाच ।

आनयेष्वरोभनं वङ्गं विज्ञाचलसमुद्धवम् ।

गालयेद्यद्यपूर्वेण टासेत् क्षमाण्डजे रसे ॥ ५८ ॥

दिःसप्तकष्टते तच^३ जायते निर्मलं शुभम् ।

तदुत्थान् कारयेत् पश्चान्^४ शुचिविहान् यथोदितान्

॥ ५८ ॥

रक्षयेद्यद्यपूर्वेण आनयेद्यवर्किकं^५ पयः ।

भावयेत् शुक्तिकाचूर्णम् उज्जूलं वङ्गिशोधितम् ॥५९॥

- (1) दाता च, a variant in A and B.
- (2) दायकः, a variant in A and B.
- (3) ते च is the incorrect variant in A and B.
- (4) A and B read तदीकान्, which is incorrect. The word पश्च is used here in the masculine gender.
- (5) B reads वट्रिक्षं.

मर्हयेद्यन्नपूर्वेच यावङ्गेपः सुलक्षणे^१ ।
 यवाहै सेपयत्वेव पवान् तु यन्नपूर्वकम् ॥ ६१ ॥
 छायाशुष्के च संजाते दापयेच्छुक्तिसंपुटे ।
 चूडाधो सेपयत्वेव सन्धो यद्वेन सुद्रयेत् ॥ ६२ ॥
 मेलितौ माषगोधूमौ पिष्टलेपं प्रदापयेत् ।
 छायाशुष्के च संजाते सूक्ष्यं लेपं दापयेत् ॥ ६३ ॥
 सुशुष्के च^२ गजे पाञ्चं स्वाङ्गशीतं^३ समुदरेत् ।
 जायते उच्चवलं वह्नं वातशुष्कं तु कारयेत् ॥ ६४ ॥
 यः केचित् मूर्च्छितस्यैव^४ जीवयेज्जीवनक्रियाम् ।
 स हि वह्नाश्रयेणैव^५ उच्चवलः कठिनो^६ भवेत् ॥ ६५ ॥

- (1) यावङ्गेपत्व वचते, a variant, which seems to be incorrect.
- (2) सुएष्टेन, a variant in A and B.
- (3) स्वानशीते, a variant in A and B.
- (4) ये केचित् मूर्च्छिते ते च, an incorrect variant in A and B.
- (5) सहित्यनाश्रयेणैव, a variant in A and B, which is unintelligible.
- (6) A and B read उच्चवलं कठिनं, which is incorrect.

अतिशृङ्खलरं तत्त्वं जायते नात्र संशयः ।
 सर्वकर्माकरं श्रेष्ठं नानाभागेन पुर्णितम् ॥ ६६ ॥
 भोगभागसमायुक्तं वह्नं च गुणसंयुतम् ।
 लक्षणार्थे^१ धनार्थे च^२ संयोगे साधयेत् सदा ॥ ६७ ॥
 जायते सुभगं तत्त्वं संसारे शोभनं भवेत् ।
 अनेनैव प्रकारेण जायते धनसम्पदः^३ ॥ ६८ ॥

पार्वत्युवाच ।

चपौ शुद्धतरे जाते का क्रिया वद मे विभो ।
 लक्षणार्थं धनसंपत्तेः क्रिया या च पृथक् पृथक् ॥ ६९ ॥

महादेव उवाच ।

लक्षणेन^४ च नारीषां भिक्षा भिक्षेन वर्तते ।
 अनेका धनदा विद्या जायते सुभगा महत् ॥ ७० ॥
 अतीव शोभना सा च गुणसामर्थ्यदायिका ।
 येन विज्ञानमाचेण साधके धनसुक्षमम् ॥ ७१ ॥

(1) B reads लक्षणार्थे.

(2) धनार्थे is omitted in B.

(3) जायते धनसंपदा, a variant in A and B.

(4) A and B read लक्षणे.

जायते नैव सन्देहो धनसामर्थ्यकं महत् ।
 अतिसौभाग्यसम्पत्तिर्जयते नादं संधयः ॥ ७२ ॥
 आनयेत् शुद्धं तं वङ्गं गालयेत् टङ्गणेः सह ।
 पिष्ठाकसुरसे दिव्ये ढालयेद्यन्नपूर्वकम् ॥ ७३ ॥
 सप्तढालक्षते शुद्धे कठिनं रजतोपमम् ।
 जायते नैव सन्देहः पुच्छिते रजते शुभे ॥ ७४ ॥
 रजतं जायते शुद्धं संभारं कारयेत् सुधीः ।
 अन्येष्वेव विधिर्दिव्यो दिव्यरजतसंभवः¹ ॥ ७५ ॥
 आनयेत् शोधितं वङ्गं तदर्द्धं पारदे छलेत् ।
 निधाय² शोभने खले तुर्यांशे दापयेत्ततः ॥ ७६ ॥
 मर्हयेत् कन्यकावीर्यं यामं षोडशं यन्नतः ।
 हंसपद्मा रसे दिव्ये तत्कमं मर्हयेत् सुधीः ॥ ७७ ॥
 समानाऽरसेनैव मर्हयेद्यन्नपूर्वकम्³ ।
 क्षायाशुष्के च⁴ संजाते शोषान्ते⁵ वासुके पचेत् ॥ ७८ ॥

- (1) दिव्यादिव्यं रजतसंभवा, a variant in A and B.
- (2) A and B read निधाय or निधाय.
- (3) यन्नपूर्वकः, a variant in A and B.
- (4) क्षायाशुष्केन, a variant in A and B.
- (5) A reads शोषाति. B reads शीषाति.

अनेनैव प्रकारेण क्रमादन्तिं प्रदापयेत् ।
 प्रहराष्टकेऽष्टकेनैव विवारं हठं दापयेत् ॥ ७६ ॥
 जायते च रसं दिव्यं भक्षणे च सुधासमम् ।
 नारौणा दापयेद्यद्वे संयोगे नागकेसरैः^१ ॥ ८० ॥
 तदर्थाः सुषुप्तुं गोधूमाः सहैवं तोलकार्द्धम् ।
 अतिसौख्यकरं तच्च^२ रक्तिमात्रार्द्धं वर्जते ॥ ८१ ॥
 पुंसि अजगुणोपेते यथा च गंधकी गतिः ।
 नरार्थं भक्षणे यातो जातिव्यसमन्वितः ॥ ८२ ॥
 अनेनैव प्रकारेण क्रमेण वर्जयेद्रसम् ।
 जायते रसजा सिद्धिः नाच कार्या विचारणा ॥ ८३ ॥
 सुखत् सुधाकरं वर्ज्ञं गालयेद्यद्वपूर्व्यकम् ।
 तज्जलं शोषयत्येव शतांशे रसदापिते ॥ ८४ ॥
 रजतं जायते शुद्धं कलाहात्रिंशतः स्फुटम् ।
 अन्यं वै मेलयत्येव विक्रये शुभदं महत् ॥ ८५ ॥

(1) A reads नागकेसरै.

(2) B reads विषु.

(3) A and B read ते च, which is incorrect.

चनेनैव प्रकारिष्व जायते धनसुंपदः ।
 साधयेत् सिद्धिदा विद्या देहसामर्चदायिनी ॥८३॥
 मिलयेद्भोगभागेन महेनाहरदो विधिः ।
 पौते भावनया अम्बो^१ सार्वहृतेन सिद्धयेत् ॥ ८४ ॥
 शुद्धताम्बे प्रदातव्यं शताये हाटकोलमम् ।
 जायते नाच सन्देहो यथा आम्बूनदीङ्गवम् ॥ ८५ ॥

* * * *

पार्वत्यवाच ।

ताम्बं च तुत्यजं दिव्यं जायते केन विक्रियाम् ।
 वद विष्णेश्वर शशो सिद्धि ताम्बविधानकौम^२ ॥८६॥
 महादेव उवाच ।
 शृङ्ख शुद्धक्रियां दिव्यां तुत्यताम्बस्तु सभवाम् ।
 येन विज्ञानमाचेण साधयेद्भृत्युम्पिकाम् ॥ ८७ ॥
 साधयेत् पश्चामृतं दिव्यं महासौख्यप्रदायकम् ।
 ज्ञात्वा करुणेन लौयेत संसारसुखभाजने ॥ ८८ ॥

- (1) A and B read रप्ती, which is incorrect.
 (2) सिद्धा शार्वविधानक, an incorrect variant in A and B.

आनयेत्त्यकं दिव्यं पौत्रगन्धकसम्बवम् ।
 हापयेष्ठोभने खले प्रकैक्षीरेण भावयेत् ॥ ६७ ॥
 मर्हयेद्यदपूर्वेण याममावमखण्डितम्¹ ।
 तेनैव धातुयोगेन सुवर्णे² सुलभतां द्रजेत् ॥ ६८ ॥
 एतादृशी परा धातुर्वर्त्तते धातुर्मध्यमा ।
 सुलभा शुभदा प्रोक्षा मम साक्षिग्यगा सदा ॥ ६९ ॥
 पावर्त्यवाच ।
 ये गुणा नागजे ताम्बे वद विश्वस्य वल्लभ ।
 प्रयोजनवस्तु शक्यं चतुरेणेव चोदितम् ॥ ७५ ॥
 महादेव उवाच ।
 अनेका गुणा³ नागेषु पूर्वसुक्षा हि⁴ पारदे ।
 किञ्चित् शेषतरा ये च शृणु देवि प्रयत्नतः ॥ ७६ ॥

- (1) A reads याममाव मखंडितः. B reads याममावे मखण्डितः.
- (2) A and B read सुवर्णः.
- (3) अनेकान् गुणान्, a variant in A and B.
- (4) सुक्षानि पारदे, an incorrect variant in A and B.

नागस्य सम्भवं ताम्ब॑ मध्ये मेलापनं क्षातम् ।
 विभागे तु क्षाते तच¹ जायते कुम्भिका शुभा ॥ ८७ ॥
 तम्भाष्ये गालयेकार्गं त्रिवारं यद्यपूर्वकम् ।
 जायते निर्मलं स्वर्णम् उदितं चेव कुम्भिके ॥ ८८ ॥
 विभागे साम्भ्रतं दत्त्वा अमृतं जायते शुभम् ।
 उक्तकार्थ्यकराश्वेते मात्यथा वचनं भम् ॥ ८९ ॥
 तम्भात् साधयते दिव्यं भूनागोङ्गवजं शुभम् ।
 अनेका साधयेद्विद्या रससामर्थ्यदायिका ॥ १०० ॥

Colophon in A

इति श्रीहृदयामले उमामहेश्वरसंवादे सुवर्णकल्पे
 सुवर्णप्रशंसा नामाध्यायः ।

Colophon in B

इति श्रीहृदयामले उमामहेश्वरसंवादे धातुमञ्जर्यां
 सुवर्णप्रशंसा समाप्ता ।

(1) A and B read ते च, which is incorrect.

Extracts from
SUVARNATANTRA
or
SVARNATANTRA.

सुवर्णतन्त्रात् वा स्वर्णतन्त्रात्
उच्छृताः श्लोकाः ।

A = MS. from Benares. *

B = MS. from Ramnákkáli's matha, Dacca. †

श्रोगणेशाय नमः ।

श्रीराम उवाच ।

देवदेव महादेव ऋषिदुष्टि फलप्रद ।
पूर्वे संस्कृता जट्ठौ रसायनपरा परा ॥ १ ॥
यस्माः साधनमाक्षेण स्वाराट्तुस्यो नरो भवेत् ।
तां सिद्धिं वह मे देव यदि त्वं भक्तवत्सः ॥ २ ॥

* The name of this MS. is सुवर्णतन्त्रम्.

† The name of this MS. is स्वर्णतन्त्रम्.

पूर्वं तु कथितं देव रद्धतन्म ल्या मम ।
 गुटिकाः कथिताः पूर्वं सहस्रद्वितयं शिव ॥ ३ ॥
 पारदाः कथिताः पूर्वं षट्शतं भूतिरूपकाः ।
 धातूनामष कल्पास्तु पूर्वमेव प्रकाशिताः ॥ ४ ॥
 धातुयोगाख्यकल्पस्तु पूर्वमेव प्रकाशितः ।
 रद्धानां करणे तन्म पूर्वमेव प्रकाशितम् ॥ ५ ॥
 किन्तु खण्डाख्यतन्म तु न मझं कथितं प्रभो ।
 कश्यपेन महेशानाभ्यदिंतोऽस्मि महेश्वर ॥ ६ ॥
 भूमिदानं मया दत्तम् ऋषये कश्यपाय वै ।
 कश्यपेन मयि प्रोक्तं भूमिभागं त्वज प्रभो ॥ ७ ॥
 स्थानायं तु महेशान रक्षाक्षिः प्रार्थितो मया ।
 वाणमात्रं खलं तेन दत्तं मम महेश्वर ॥ ८ ॥
 स्थानं प्राप्तं महेशान भक्षणं मम नास्ति वै ।
 भक्षणं देहि मे देव यदि पुच्छोऽस्मि शङ्कर ॥ ९ ॥

ईश्वर उवाच ।

शृणु राम प्रवक्ष्यामि रहस्यातिरहस्यकम् ।
 स्वर्णतन्माभिर्धं तन्म कल्परूपेष्व कथ्यते ॥ १० ॥

तदायां स्वर्णतमसा कर्त्तुं शृणु सुपुत्रक ।
 तैलकन्दाभिधः कन्दः सिङ्गकन्दः प्रकौर्तिः ॥ ११ ॥

कन्दः कामलवत्तस्य पचाणि कञ्जवच्छशो ।
 तथैव तु महत्पत्रं तैलं स्नेयति सर्वदा ॥ १२ ॥

जलमध्ये सदा पुत्र त्वार्द्धं एव प्रतिष्ठते ।
 विषकन्देति विस्थातो विषाच्च कायनाशनः ॥ १३ ॥

तैलस्नावी महाकन्दः परितस्तैलवज्जालम् ।
 दशहस्तमिति देशे सरते तैलवज्जालम् ॥ १४ ॥

महाविषधरः पुत्र तदधो वसति ध्रुवम् ।
 कन्दाधः कन्दस्त्रायायां नान्यच गच्छति प्रिय ॥ १५ ॥

तत्परीक्षाविधानार्थं कन्दे सूचीं प्रवेशयेत् ।
 सूचीद्रावः वस्त्रात् पुत्र तत्कन्दन्तु समाहरेत् ॥ १६ ॥

तत्कन्दं तु समादाय शब्दसूतं खलेन्निधा ।
 मूषायां निक्षिपेत् तन्तु तत्त्वैलं तद्र निक्षिपेत् ॥ १७ ॥

दीपाम्बिं तु महाराम वंशाङ्करेण दापयेत् ।
 तत्क्षणाङ्कृतिमायाति लक्षवेधो भवेत् सुत ॥ १८ ॥

ततः प्रभज्येद्रामः कुचिद्राहारको ध्रुवम् ।
 तालं शुर्वं समानोय तत्त्वैन खलेत् सुत ॥ १९ ॥

सप्तधा प्रत्यहं राम त्वेवं विशद्दिनं ध्रुवम् ।
 हरितालो मृतिमेति निर्धूमो जायते ध्रुवम् ॥ २० ॥
 अग्नी पुत्र ततो दद्याच्चिर्धूमो जायते सुत ।
 तत्सालं चाषधाती तु दद्याहृत्वे छते सति ॥ २१ ॥
 सर्ववेद्धो भवेदेव शतविहो भवेत् सुत ।
 तत्सैलं तु समादाय ताम्बद्रावे विनिच्छिपेत् ॥ २२ ॥
 तत्क्षणात्ताम्बवेधः स्यात् दिव्यं भवति काष्ठनम् ।
 वह्ने कांस्ये यदा दद्यात्तदा रौप्यं भवेत् सुत ॥ २३ ॥
 ताम्बे लौहे तथा रीत्यां तारे खर्परसूतके ।
 तत्क्षणात् वेधमायाति दिव्यं भवति काष्ठनम् ॥ २४ ॥*

ग्रंखद्रावस्य भेदान् हि तत्क्षणान् शृणु साम्रातम् ।
 लौहद्रावस्याथा ताम्बद्रावयैव हितौयकः ॥ १ ॥
 ग्रंखद्रावस्यतौयः स्यात् हृत्सालश(?) चतुर्थकः ।
 दद्याद्रावः पञ्चमः स्यात् अग्नवेधो तु मध्यमः ॥ २ ॥

* The above 24 Slokas are not found in MS. A.

पञ्चानां तु परौच्चा वै कथते शृणु साम्रातम् ।
 लौहसूचीं समादाय लौहद्रावे विनिक्षिपेत् ॥ ३ ॥
 तत्त्वणाद्वतां याति सा सूचौ नाव संशयः^१ ॥
 ताम्बद्रावे तथा सूचीं सम्भिर्दीर्घे विनिक्षिपेत् ॥ ४ ॥
 सूचीद्रावो याममादादभवत्येव न संशयः ।
 शंखद्रावे शंखसूचौ चतुर्यामेन संद्रवेत् ॥ ५ ॥
 हृत्सालोऽधी^२ यदा गच्छेत् दत्तात्राधी भवन्ति हि ।
 दत्तद्रावोऽप्यधो गच्छेददत्तद्रावो भविष्यति ॥ ६ ॥
 एवं परौच्चां क्षत्वादौ प्रयोगानारभेदप्रवृत्तम् ।
 वज्रमूषां ततः क्षत्वा शृद्धसूतं विनिक्षिपेत् ॥ ७ ॥
 लौहसूचौद्रावरसं तत्र यदेन निक्षिपेत् ।
 तत्राम्नि दापयेद्यन्नात् पुनस्तत्र^३ रसं क्षिपेत् ॥ ८ ॥

- (1) The above 7 hemistichs are not found in A.
- (2) A reads दत्तात्राधी. B reads दत्तात्राधी. Both the readings seem to be incorrect; since B has हृत्साल
चतुर्यक्षः in the 2nd Sloka.
- (3) B reads पुनस्तत्र, which is not correct.

~~~~~

स सूतो भृततामेति<sup>१</sup> नाव कार्या विचारणा ।  
 अष्टधातुषु तं सूतं दक्षा काञ्छनतां ब्रजेत् ॥ ८ ॥  
 तं सूतं भक्षयेद्यो हि सोऽमरत्वमवाप्नुयात्<sup>२</sup> ।  
 तस्य मूवपुरौषेषु शुल्कं<sup>३</sup> भवति काञ्छनम् ॥ १० ॥  
 ताम्बद्रावप्रयोगं वै शृणु यद्वेन साम्रातम् ।  
 तद्रसं तु समादाय शुद्धताम्बे विनिर्दिष्टेति<sup>४</sup> ॥ ११ ॥  
 तत्ताम्बं स्वर्णंतां याति भैरवस्य प्रसादतः ॥ १२ ॥

Colophon in A—इति श्रीसुवर्णंतंत्रे हरपाद्वैतौसंवादे  
 दुस्यर्थकल्पः हितीयः ।

Colophon in B—इति स्वर्णंतंत्रे लोहद्रावादिपञ्च-  
 फलकल्पो हितीयः ।

- (1) B has सा सूची वर्तिमान्नीति.
- (2) A reads स गच्छेदमरत्वतां, which is incorrect.
- (3) B reads तुल्य.
- (4) शुद्धताम्बे शु निर्दिष्ट, a variant in B.

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